ATLANTIC PROVINCES

FIELD CROP GUIDE

Prepared by the
ADVISORY COMMITTEES ON
CEREAL, PROTEIN, CORN
AND FORAGE CROPS

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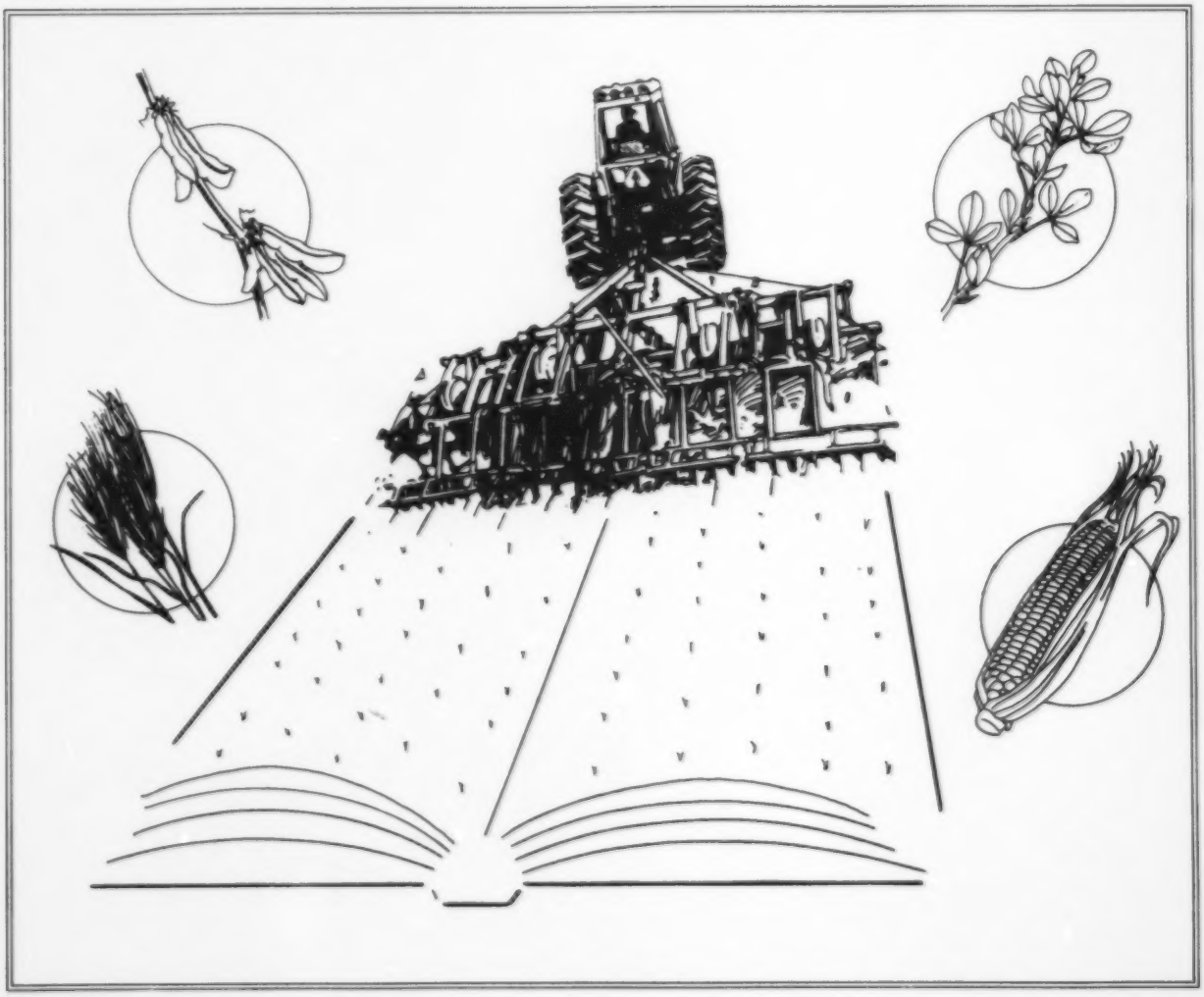

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The FIELD CROP GUIDE contains the pooled findings and recommendations for Atlantic Agriculture. All sections were prepared by representatives of the Advisory Committees and Subcommittees of the Atlantic Provinces Agricultural Services Co-ordinating Committee. The New Brunswick Department of the Environment provided information on Pesticides.

Since publication is at intervals of several years, specific recommendations will change before the next issue appears. In view of this, care should be taken to check on approved recommendations from time to time.

Specific variety and pesticide recommendations are found in Publication 100A — the annual supplement to this book.

More detailed and, at times, more current, agricultural production and management information is contained in publications available from the nearest Agricultural Representative.

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(see page 48) _____

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Climate

Introduction

The climate of a region determines to a large degree the kinds of crops that can be grown. Selection of crop, cultivar or hybrid, time of planting and rate of development are all dependent on the weather. Although many important daily decisions are made based upon the two to five day weather outlook, there are some major longer-term decisions projected over five years, ten years and much longer that require the best available information as to the type of growing conditions a farmer will expect to have on his land.

Long-term weather stations in the Atlantic Region help determine the amount and range of rainfall and temperatures an area usually receives. This can be combined with knowledge of the terrain and marine influences to draw maps reflecting the average climate of the region. The accompanying maps on precipitation, frost-free periods and growing degree days were constructed from 233 climate stations with climate data available for the 1951-1980 period. This rainfall and temperature data can be a useful guide in determining if an area or farm has enough moisture, enough heat or an adequate number of frost-free days to grow a specific crop. Time of planting, dates of fertilizer application, disease and pest development rates, cutting and harvesting schedules and several other management decisions require long-term estimates of the climate of the area.

The climate of the region varies significantly as the map lines indicate. Farm level climate can vary significantly depending upon the field location. Through proper site selection, variety selection and long-term planning, the microclimate of the farm can be utilized to improve production and save dollars.

Climate Normals

A long period of weather observations is necessary to understand the expected variety of weather on the average. The term "Climate Normals" is used to describe the average data for a 30-year period.

Climate normals represent the average of widely varied yearly values which occurred over a 30-year period. The period in use at publication date is 1951-1980. However, by 1993, that period will have been updated to 1961-1990. When evaluating crop performance in any given year, compare that year's weather to the climate normals to judge whether the season and crop performance were typical.

(i) May-September Precipitation

The precipitation normals are based upon daily observations of rainfall from May 1st to September 30th inclusive for the 30 year time period. In the Atlantic region, the precipitation varies from 400 mm to 600 mm during the growing season.

(ii) Growing Degree-Days (Heat Units)

Temperature affects plant processes mainly by controlling the rate of growth. There are certain minimum temperatures below which plants do not grow. For perennial forage production, a threshold temperature of 5°C is most valid. The value of 5°C is used because at that average temperature, the daily maximum is about 10°C and the minimum is 0°C. Most plants do not grow when minimum temperatures are below 0°C. The growing season for forage production is defined as the number of days between the date in the spring when the average temperature rises above 5°C and the date in the fall when the average temperature drops to 5°C.

The concept of growing degree-days, or heat units, assumes that plant growth is related directly to the average temperature. To compute degree-days for a particular day, calculate the average of the maximum and minimum temperature for the day, then subtract the base temperature from the average temperature.

Example:
Maximum Temperature = 24°C
Minimum Temperature = 16°C
Average Temperature = 24 + 16 = 40/2 = 20°C
Degree-days above 5°C = 20 − 5 = 15

If the daily average temperature is below the base temperature, the degree-day value is zero. Negative values are not used because the crop is not set back. When using degree-days, be sure to know what base temperature, and temperature scale have been used. Corn heat units are widely used for corn hybrid maturity rating. They differ from degree-days described above in that the maximum and the minimum temperature are used separately to assess the contribution to corn development. Higher maximum temperatures are preferred and are given more weight than cooler minimums, reflecting the heat loving nature of the crop.

Degree-day information is used to indicate heat available in an area for crop production. Select crops or varieties with a heat requirement matched to the location.

(iii) Frost-Free Days

The growing season for frost sensitive crops is determined by the last spring frost and first fall frost. Although coastal locations have long frost-free periods, they do not have the high temperatures required for the rapid growth and maturity of warm season crops.

Frost normals can vary significantly within short distances due to the effect of steep terrain or large bodies of water (see section on Farm Level Climate). It is important to have a long period of record if possible when mapping this factor. The normal frost-free periods range from less than 70 days in central Newfoundland to 170 days in some Maritime coastal zones.

Farm Level Climate

(i) Introduction

The climate at the farm level can be different than the climate of the surrounding area. Local features interact to produce a micro-climate unique to the location. Knowledge of these factors provides a better understanding of what to expect on your farm in the future. The factors that influence the climate at the farm level are:

- topography
- slope & aspect
- elevation
- marine influences
- wind

(ii) Topography

Topography has a marked effect on the incidence of frost. After sunset, the ground cools rapidly and its temperature soon falls below that of air in contact with it. The surface layer of air becomes cooler and heavier. Over sloping

ground, this cooled surface air tends to drain to lower levels and to collect in depressions or hollows. In a frost hollow, drainage of cold air into the depression results in frosts much later in the spring and earlier in the autumn than at surrounding locations. Hillside locations will, on the average, tend to have longer frost-free periods than neighbouring stations on lower ground or in a valley.

Night winds influence temperature differences between hillsides and valleys on clear nights. The best conditions for cold air drainage are found when there is no general air movement. Even a light wind will serve to mix the relatively warm air above with the thin layer of surface air which has cooled through contact with the ground. Moderate winds will prevent differences in temperature between hillsides and valleys.

(iii) Slope and Aspect

Slope plays a major role in farm level climate. Valley bottoms experience colder nighttime temperatures and usually warmer daytime maximums than either midslopes or hilltops. The total heat units over an entire growing season are usually highest on midslopes, less on hilltops and lowest in valley bottoms. This order is much more pronounced when heat units are accumulated between frost dates. Cold air running down the slopes and pooling in valley bottoms causes later spring and earlier fall frost dates. Hilltops usually have a shorter frost-free period than midslopes because of greater exposure to radiative loss to the atmosphere at night. Exposed hilltops have slightly cooler maximum temperatures than midslopes. In winter, midslopes accumulate more snow than hilltops, particularly on the lee side of the prevailing winds. The influence of aspect can change these relationships.

Aspect, or orientation to the direction of the sun, has two roles in crop production. In winter, south facing slopes produce warmer conditions that may result in harmful freezing and thawing cycles. Snow melt accounts for less depth and denser snow packs on south slopes. This results in a decrease in the protective value of the snow which may be important to overwintering perennial crops. In contrast, the growing season conditions are more favourable on south slopes. Warm south and west facing slopes provide more heat units and higher soil temperatures early in the season. Spring soil moisture conditions are generally wet, depending upon soil type. In this instance, south slopes have higher evaporative losses and the field trafficability is earlier as a result.

(iv) Elevation

Elevation has the most influence on precipitation totals and heat unit accumulation. Generally, higher elevations have lower heat units. Precipitation increases with elevation because warm moist air masses are forced upwards by rising land, the air mass cools and the moisture falls out as rain or snow. The proportion of precipitation that falls as snow increases with higher elevation.

(v) Marine Influences

Bodies of water exert a modifying influence on the climate of surrounding localities. Water bodies cool the local climate in summer and warm it in winter. This effect is most pronounced near the coast, but may extend inland several kilometers depending on elevation, topography and prevailing winds.

Water bodies may also extend the frost-free period. Near the ocean at night, land breeze circulations draw cool air away from the land areas. Inland, lakes and rivers heat the air which drains at night to valley floors. Lakes and rivers also yield large amount of moisture to the air. When this air cools, fog forms. All of these processes inhibit the formation of frost and extend the frost-free season.

(vi) Wind

Exposure to high winds is usually detrimental to crop production, and many studies indicate better yields in protected or sheltered areas. Two suggested reasons for this are desiccation of plants from high evapotranspiration losses and physical damage to plants directly from the wind. The establishment of some barrier to the wind on the prevailing wind side, may be required to improve the situation. If additional winter snow cover is desirable, wind breaks will increase this cover. In Atlantic Canada, summer winds are usually from the south and southwest while winter winds are from the north and northeast.

Agroclimatic Maps

The prevailing wind direction and the relationship of land to water is a major factor determining climatic differences within the region. The southern coasts of new Brunswick, Nova Scotia and Newfoundland have the highest annual precipitation in Atlantic Canada due to southeasterly storm winds blowing moisture-laden air onshore. In contrast, the Northumberland coasts of New Brunswick and Nova Scotia, all of Prince Edward Island, and northern Newfoundland are in a "rain shadow". This means that southeasterly storm winds have already dropped most of their precipitation by the time they reach these areas and precipitation amounts are reduced.

The distribution of rainfall in the Maritimes is shown in Map 1 for a period roughly corresponding to the growing season. It is important for agricultural crops to have sufficient rain, evenly distributed over the growing season to meet crop water requirements. Seasonal precipitation at Sydney and Yarmouth exceeds potential evapotranspiration so they are unlikely to have crop water deficits. Parts of the eastern shore of New Brunswick and an area around Woodstock experience small deficits in July and August on a regular basis while parts of the Annapolis Valley and the north shore of Nova Scotia, depending on soil type, may have soil moisture deficits in years with below normal rainfall. In Newfoundland (see Map 1A), the maximum rainfall occurs along the south coast and falls off rapidly inland. The Long Range Mountains receive fairly high rainfall.

The growing season for frost sensitive crops is determined by the last spring frost and first fall frost. The frost free period varies a great deal depending upon latitude, elevation, topography, and proximity to large water bodies. Although coastal locations have long frost-free periods, they do not have the high temperatures required for the rapid growth and maturity of warm season crops.

In Map 2, the longest frost-free periods are along the southwest coasts of New Brunswick, Nova Scotia and Prince Edward Island. The frost-free period decreases rapidly with distance away from the moderating influence of the ocean. The coastal area along the Northumberland Strait has a frost-free period of about 130 days very near the water. Inland areas and the higher elevations have the shortest frost-free periods.

The longest frost-free period indicated in Map 2A is along the south coast from Burgeo to Cape Ray. The next longest frost-free period is along the south, west and east coasts. Inland areas and the eastern part of the Northern Peninsula have the shortest frost-free period. The interior of the Province has a frost-free period of only 70 days.

The largest heat unit totals in the Maritimes are found in the Annapolis Valley of Nova Scotia, the Grand Lake area of new Brunswick, and the coastal area along the Northumberland Strait. (See Map 3A). Cold Atlantic waters reduce degree-day totals along the Bay of Fundy. This influence decreases with distance inland. The warm waters of the Northumberland Strait keep the adjacent coastal areas warm.

The northeast part of Newfoundland, including the northern part of the Avalon Peninsula, has the most heat units in the Province. (See Map 3A.) This area is sheltered from the prevailing southwesterly winds. A narrow coastal strip from Corner Brook to Stephenville also has high heat unit totals, in this case due to the influence of the warm waters of the Gulf of St. Lawrence. The high elevation areas of the Long Range Mountains have the lowest heat unit totals. Most coastal areas have low heat unit totals.

Publications Which Provide More Climatic Information

The Climate for Agriculture in Atlantic Canada, Atlantic Committee on Agrometeorology A.C.A. 1985.

Spring Field Work days in the Atlantic Provinces, A.C.A. 1978

Probability of Freezing Temperatures in the Spring and Fall in the Atlantic Region, Publication 1565, Agriculture Canada 1975.

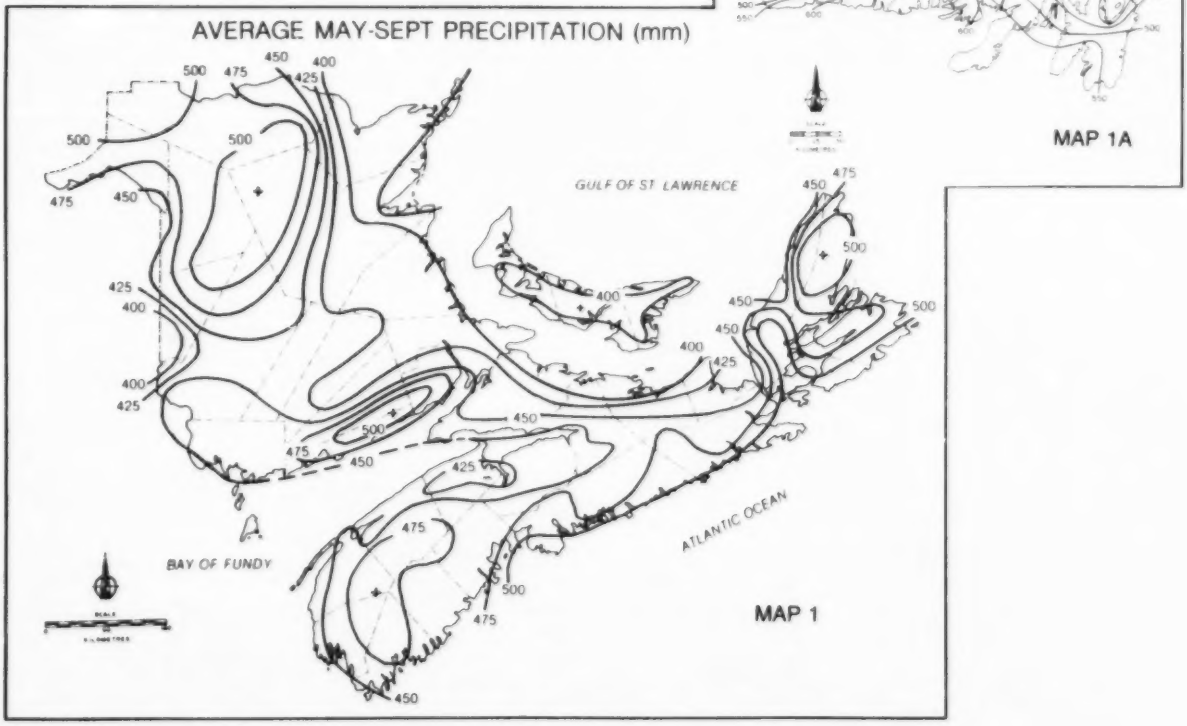
Growing Degree-Days and Crop Production in Canada, Publication 1635, Agriculture Canada, 1977.

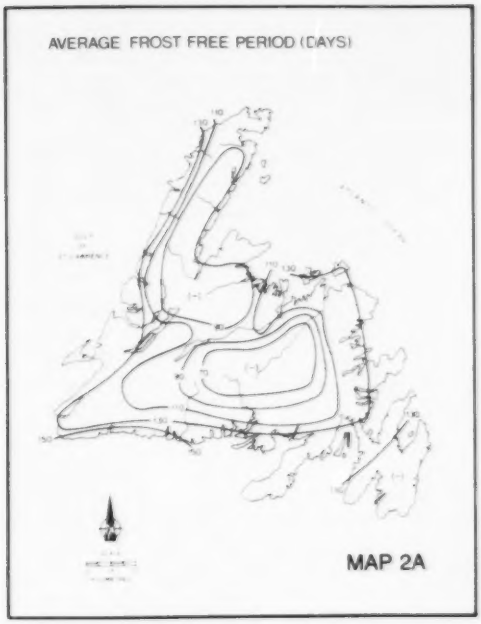
Climate Zonation for Forage Crops in the Atlantic Region, Agriculture Canada, 1984.

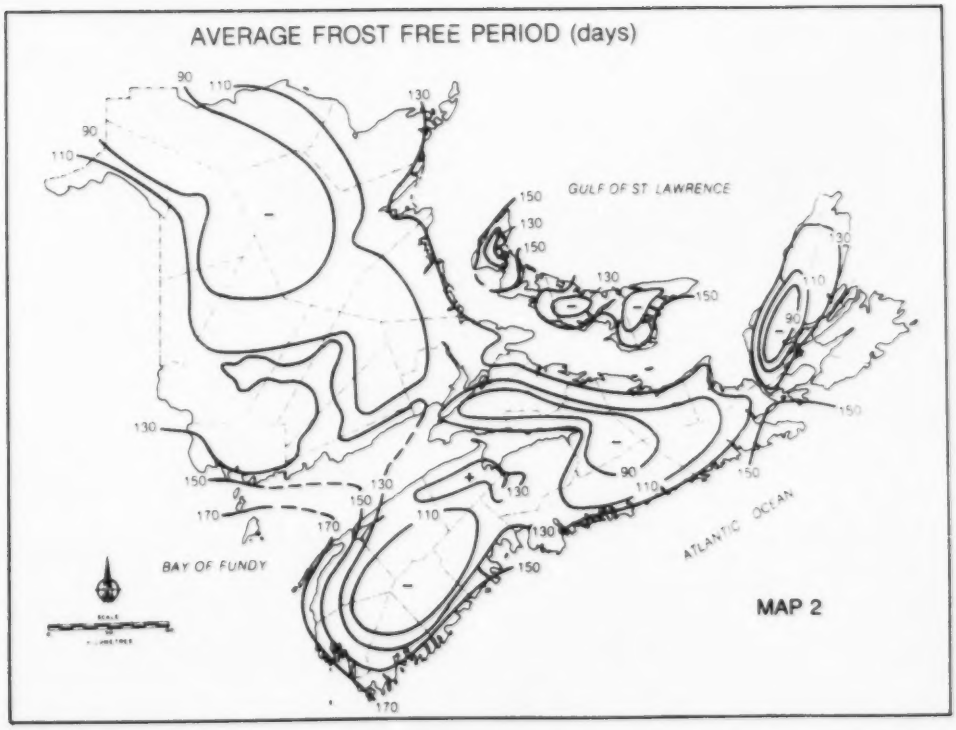
Risk Analysis of Heat Units Available for Corn Production in the Maritime Provinces, Agriculture Canada, 1991.

To obtain these publications, or get more information on a climatic topic, contact your District Agricultural office, provincial climatologist or crops specialist.

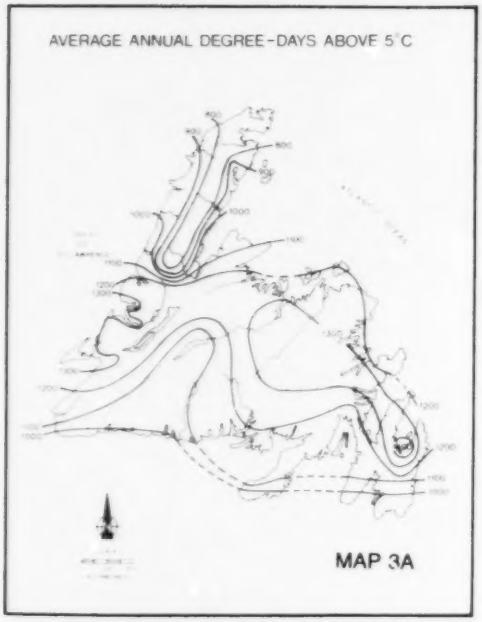
Map 1 and Map 1A. Average May-September precipitation (mm).

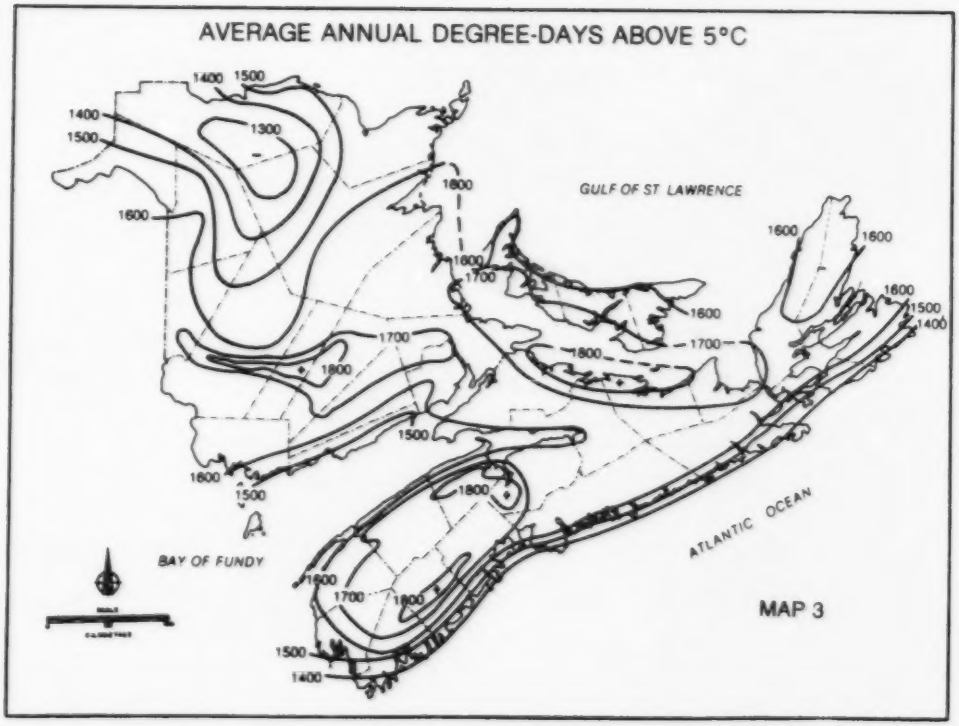






Map 2 and Map 2A. Average frost free period (days).





Map 3 and Map 3A. Average annual degree days (heat units) above 5°C.

Forage Production

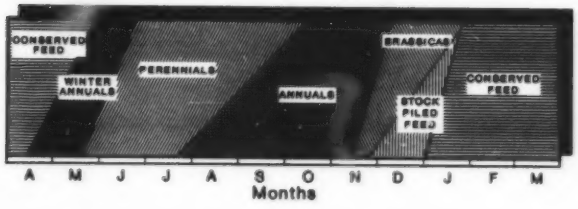
Introduction

A forage program must supply high quality feed on a year round basis. No single forage species or mixture will supply the total forage requirement of a livestock farm. The crop grown and storage method is unique to each farm since the choice is based on capital, equipment, land, labor, time of year forage is required, size of operation, type of livestock, personal likes and dislikes. On most farms, the forage program will use several perennial and some annual species as hay or haylage, pasture and zero-graze.

Production of good quality forages requires the forage crop be managed as intensively as other high yielding crops. Proper management of forages includes variety selection, fertilization, pest control, cutting frequency, and fall management of the forage.

Good forage management must be based on the climate, soils, and end use of the forage for each farm.

Figure 1 — Total Forage Program for Pasture and Stored Feed



A program of annual and perennial forages as pasture and stored feed provides good quality forage year round.

Forage Establishment

Perennial forage plants must develop sufficient size and root reserves to survive winter temperatures and regrow the following spring.

Spring seeded forages should have adequate development to overwinter well and also provide 2 to 3 t/ha of dry matter the seeding year. Fall seeding of legumes is not recommended due to insufficient time for adequate root system development.

Seedbed Preparation

Small seeded legumes and grasses require a fine, firm seedbed in order to get uniform planting depth and germination. Overworking the soil or use of large tillage equipment may result in a very loose seedbed that needs to be firmed with a cultipacker or roller before seeding. Working the soils too early, when the soil is too wet, can lead to crusting and water logging which causes poor emergence of legumes.

Seeding Method

The small forage seeds should be distributed uniformly and covered with 1 cm of soil. If the soil is extremely dry, a slightly deeper placement into moist soil may be beneficial. Either a drill or cultipacker seeder (e.g. Brillion) may be used. Cultipacker seeders place the seed uniformly in the upper I cm of soil and firm the seedbed immediately after planting. Many drill seeders allow the placement of fertilizer in bands below the seed. This is beneficial as seedlings require phosphorous. Seed tubes can be attached to the drill to place the seed directly over the band of fertilizer for maximum benefit.

Inoculation of Legumes

Legume seed must be inoculated with the proper Rhizobium inoculum before planting. The inoculum contains bacteria which form nodules on the roots of legumes to fix nitrogen from the air. The correct inoculant must be chosen for each legume. Packets of commercially available inoculant contain live bacteria and should be stored in a cool dark place.

One package of Rhizobium inoculant contains enough bacteria to treat 25 kg of legume seed. The inoculant should be mixed with the seed prior to seeding. Creating a slurry, by mixing the inoculant with 250-400 ml of water, is an effective method of inoculation. This slurry should then be thoroughly mixed with the seed to ensure effective root nodulation. Seed that has been inoculated and stored should be re-inoculated to ensure viable bacteria are on each seed at planting.

Coated Seed

Coatings used on forage seed contain various combinations of inoculating bacteria, lime, nutrients and bonding agents. Coatings are intended to improve emergence and establishment of forage stands. Coating can be an effective but usually unnecessary measure to ensure good inoculation of legume seed. Carry over coated seed should be re-inoculated to ensure the presence of live bacteria in the year of seeding.

Coated seeds are larger than uncoated seeds therefore, a kilogram of coated seed contains fewer seeds than an equal weight of uncoated seed. To plant recommended rates of seed, the setting on the seeder may have to be increased. Some limited research indicates seeding rates can be reduced with coated seed.

Coated seed may have a role in assisting in the reintroduction of legumes into pastures or hay fields particularly in minimum tillage situations.

Weed Control

Weed control is the process of limiting weed growth and infestations to allow efficient and profitable forage production. Total weed eradication is expensive and not necessary for forage production. A weed control program should be designed to reduce the weed population to a level that is not economically damaging.

Weed control is an integral part of crop production. A good program starts by identifying the problem. Knowing what weeds are present in the crop allows selection of the most effective control. Take an inventory of the type and severity of weeds in the forage crop before harvest.

Divide the weeds into groups such as annuals and perennials; which should include both grasses and broadleaf weeds. This should be done on a yearly basis, as it allows evaluation of the current program and provides information that may necessitate changes in that program. In addition, indicate the severity of infestation of various weeds by the use of words such as: rare, scattered, occasional, common and/or abundant.

A successful weed control program will consist of two or more types of control, since relying on one control program will usually allow some weeds to escape. Types of control generally fall into four (4) main categories, namely: mechanical or physical, cultural or management, biological and chemical.

Mechanical weed control is effective in new forage stands. Clipping the field in late June or early July removes the weed flowers and allows the forage to grow. This gives some control of annual weeds, but will not control perennial weeds such as quackgrass or milkweed. Mechanical weed control methods also include most of the cultivations done to prepare the seedbed.

Cultural weed control is the practice of growing a healthy, vigorous forage crop that will out-compete weeds. All practices that improve crop growth will help reduce weed populations. Choose a well adapted variety, lime and fertilize as recommended by a soil test, plant as early as possible and fertilize older stands. A vigorously growing legume or grass crop leaves little space for weeds.

Biological weed control is practiced to some extent in areas of the Maritimes to control specific weeds by the introduction of diseases and insects. Insects are the most effective, an example being the introduction of the Cinnabar Moth to control tansy ragwort.

Chemical weed control involves the use of herbicides which inhibit the growth of unwanted plants. Herbicides are specific as to the weeds controlled, stage of crop and weed development, time and rate of application, and method of application. Herbicides are recommended only for uses and methods of application specified on the label. Always read the label before use. Herbicides should not be the only weed control method. Use them as part of a weed control program and in conjunction with sound crop management practices. For more information consult Publication 75 - Guide to Chemical Weed Control.

Direct Seeding

Figure 2 — Forage quality of perennial species under good management

	P	G	VG	E
Alfalfa			▲	
Clover - Red			▲	
- White			▲	
- Ladino				▲
- Alsike			▲	
Birdsfoot Trefoil			▲	
Timothy		▲		
Bromegrass		▲		
Orchardgrass		▲		
Reed Canary	▲	▲		
Fescue - Tall	▲	▲	▲	▲
- Meadow			▲	
Perennial Ryegrass		▲	▲	
Redtop		▲		
Bluegrass				▲

**forage quality is very dependent on management*

New forage seedings can be established without a companion or cover crop. Direct seeded forage will normally yield one cut the first year, although it will be only 50% of a regular production year. In good years, alfalfa planted in early May can be harvested in July, and again before the recommended last date of cut.

Adequate fertility, especially phosphorous, is important to direct seeded stands. Using a seed drill to band forage seed over a fertilizer containing phosphates aids seedling growth. (Refer to Figure 5)

Underseeding/Cover Crops/Companion Crops

Underseeding forage with a cereal companion crop is a traditional practice for many farmers in the Atlantic region. When it is successful, it provides several advantages. These include better erosion control, increased haylage or grain straw production in the seeding year and reduced weed growth. The cereal crop can be taken through to a grain harvest, providing the weed control is good and combining occurs early enough for the forage crop to develop properly before winter.

Problems can occur when cereals compete with forages for sunlight, nutrients, and water to an extent that the forage crop establishment is less than adequate. General experience has been that red clover and timothy establish better in underseeded situations than alfalfa and most other grasses.

Fertilizers for Forage

General

Forages utilize large amounts of nutrients to produce a high yielding crop with excellent protein content.

Soil tests provide fertilizer and lime recommendations to produce the highest economic yields when accompanied by good management. A soil test should be taken every two to three years to maintain a productive forage stand. If the stand is 60% or greater in legumes, a boron test should be requested.

Fertilizer cost is reduced and yields increased by liming the soil. Research shows that forage yields are almost doubled when equivalent fertilizer is applied to a soil at a pH of 6.2, compared to an acid soil with a pH of 5.4.

Fertilizing in the Seeding Year

Always apply lime and fertilizer based on a soil test.

Limestone should be applied the fall prior to seeding and worked into the soil in quantities sufficient to raise the pH to 6.4. Choose dolomitic limestone if your soil requires magnesium.

Figure 3 — Recommended pH for Forage Crops.

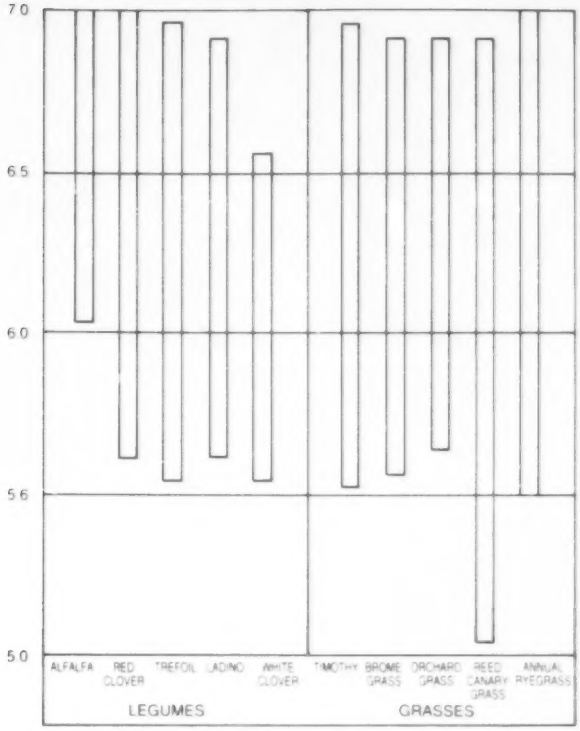


Figure 4 — Approximate Nutrient Values in Various Manures and Application Timings

Form of Manure		Nitrogen			P_2O_5	K_2O
Solid t/ha	Liquid m^3/ha	F&W* kg/ha	Spr** kg/ha	Spr.C*** kg/ha	kg/ha	kg/ha
Cattle or Mixed Livestock Manure						
20	50	25	50	60	20	90
30	75	40	75	90	30	135
40	100	50	100	124	40	180
Swine Manure						
20	30	24	50	60	24	35
30	45	40	75	90	35	50
40	60	50	100	125	50	70
Poultry Manure						
4	10	20	45	60	25	22
10	25	50	110	140	60	55

*F&W denotes fall and winter applied manure.

**Spr. denotes spring applied manure not covered immediately, including surface applications after seeding.

***SprC. denotes spring applied manure covered immediately after application.

Conversions:

66 bu manure = 1 metric tonne

10 tonnes/ha = 4.5 ton/acre

One cubic meter = 220 imperial gallons.

One cubic meter per hectare = 90 gallons/acre

Figure 5 — **Fertilization In The Seeding Year**

Recommended Practice	Kg of Nutrients per hectare			Example Analysis	Rate[3] (kg/ha)
	N	P_2O_5	K_20		
Band seeding (Seed planted in rows; fertilizer drilled 3-5 cm below seed)					
Broadcast and work in before seeding on infrequently limed and fertilized soils only	15	50	50	5-20-20	250
Band at seeding + Boron[1]	5-15	20-50	10-30	8-32-16	75 to 150
Topdress on grasses after emergence	35-50	0	0	34-0-0	100 to 150
After last cut — (legumes)[2]	0	30	100	0-10-30	300
— (grasses)	10	20	60	5-10-30	200
Broadcast Seeding (using Brillion-type seeder, fertilizer broadcaster, etc.)					
Broadcast prior to seeding	15-25	60-150	90-210	5-20-20	300 to 700
Topdress on grasses after emergence	35-50	0	0	34-0-0	100 to 150
After last cut					
— (legumes)	0	30	100	0-10-30	300
— (grasses)	10	20	60	5-10-30	200

1. Boron may be needed on legumes. Use soil testing services to determine soil levels and amounts to be applied. **Caution:** Excess boron in bands can be toxic to plants.
2. Band seeded alfalfa should produce one cut the first year. A light application of 0-10-30 plus Boron might then be applied as a top-dressing.
3. Use the higher rate where lime and fertilizer have been infrequently applied. Otherwise, use the lower rate.

Phosphorus is very important to ensure good root development and seedling establishment. Banding phosphorus 2 cm below the forage seed is beneficial if soils are low in phosphorus.

Nitrogen is required by all forage seedlings. Legumes need nitrogen to promote growth until they become nodulated and can fix their own nitrogen. Excess nitrogen applied in the fall will promote winter injury and will be lost by leaching.

Potassium should be available to plants in the fall to promote good root development, storage of food reserves for increased spring yields and development of cold hardiness to promote winter survival. Plants use more potassium than any other element.

Boron should be applied to legumes in the seeding year at rates recommended from a soil test. Excess applications may retard or even kill the forage seedlings. A soil test for boron on alfalfa should be taken every two to three years.

Manure is an excellent source of organic matter and micro-nutrients. Manure should be viewed as a resource which may be utilized to reduce the amount of commercial fertilizer required. See Figure 4 for information on the value of common manures.

Table taken from the Ontario Ministry of Agriculture and Food Publication 296, 1980 Field Crop Recommendations.

Fertilizing Established Stands

Forage stands lacking adequate fertilization will become unproductive, thin out rapidly and revert back to less productive native swards. Following a balanced fertility program (see Figure 6) will help ensure longevity of the seeded species. To maintain established forage stands for hay and silage:

(1) Fertilize annually and generously with potassium, an essential nutrient in maintaining all forage stands.

(2) While phosphorus is most essential in the seeding year, a small amount may also be required annually in the maintenance fertilizer.

(3) Nitrogen is required for a pure grass stands or mixtures with less than 50% legume. Apply fertilizer containing nitrogen in early spring and again after each cut. With several forms of nitrogen fertilizer now available, it is commonly recommended that a urea based nitrogen fertilizer be used for spring/first cut applications. Less volatile forms such as ammonium nitrate or calcium ammonium nitrate based nitrogen fertilizers are recommended for use during times of high potential evaporative loss (late June - September). Fertilizer should be applied not less than four to five weeks before harvest to ensure proper conversion to protein in the plant.

(4) Where manure is applied, reduce the rate of fertilization according to the kind of manure and rate of application (consult Figure 4).

(5) When older grass swards lose productivity, it is often more economical to reseed to a legume or legume-grass mixture than to continue high nitrogen applications.

Figure 6

Fertilization of Established Stands

Recommended Practice	Kg of Nutrients per hectare			Example Analysis	Rate[3] (kg/ha)
	N	P_2O_5	K_2O		
Stored Feed (hay or haylage):					
Over 60% legumes					
As spring growth begins	20	40	110	5-10-30	200 to 400
After each cut	0	40	100	0-10-30	200 to 300
After last cut	0	0	100	0-0-60	100 to 200
30 to 60% legumes					
As spring growth begins	50	0	0	34-0-0	150
After each cut	45	20	45	18-6-18	250
After last cut	10	20	60	0-10-30	100
Over 70% grass					
As spring growth begins	75-100	0	0	34-0-0	225-300
After each cut	75-100	20	75-100	18-6-18	390-550
After last cut	10	20	60	5-10-30	200
Pasture:					
Over 60% legumes					
Apply in mid-June, late July and early Sept.*	0	20	40	0-10-30	150
30 to 60% legumes					
Early spring mid-June* and late July*	35	35	35	17-17-17	200
Early September	25	50	50	12-24-24	200
Over 70% grasses					
Early spring	50	0	0	34-0-0	150
Mid-June* and late July*	45	15	45	18-6-18	250
Early September	25	50	50	12-24-24	200

Peat Soils: Increase the above rates by 25 to 30%. Trace elements as FTE (fritted trace elements) should be added at three to four year intervals as 2% of the fertilizer mixture, i.e. 18-6-18 + 2FTE. Formulation 504 (Frit Industries) contains B, Cu, Fe, Mn, Mo and Zn.

*Dates are approximate. These are estimates of dates when previous applications will have ceased to stimulate growth and require replenishing.

Fertilizing Pastures

Forages used for pasture have similar nutrient requirements as those grown for hay or silage. However, in well managed pastures a significant amount of nutrients can be supplied by the grazing animal in the form of manure. Commercial fertilizer can be used to stimulate early growth.

Once again, a regular soil testing schedule allows you to monitor the nutrient levels of individual fields and provide a cost effective method of tailoring fertility applications. Along with Figure 6, the following may prove helpful in assisting in the development of your own individual fertility program.

Timing of fertilizer applications, particularly nitrogen, can greatly influence pasture growth. An early spring application of nitrate fertilizer stimulates growth while soil temperatures are low and soil bacteria that release and convert nitrogen to the nitrate form are not yet active. If all pasture areas are fertilized in the spring, it will usually be necessary to harvest some of the forage as hay or silage.

For many grass pastures, split applications of nitrogen will result in better grass growth and more efficient use of applied fertilizer. When grasses are heavily fertilized especially with potassium in early spring, it is important to use dolomitic limestone to minimize the chances of hypomagnesaemia (grass tetany) developing in grazing stock. Split applications of potassium (depending on soil test) may be helpful in producing forage with a satisfactory potassium magnesium balance and preventing grass tetany. In some pasture situations, especially where white clover is being encouraged, supplemental applications of phosphorus may be recommended.

Insects

European Skipper is found in most parts of the region. The adult is an orange-brown butterfly with a 3 cm wing spread. It congregates in damp places and skips about hay fields in mid-summer. The larvae are light green up to 2 cm long caterpillars when full grown, and are usually found in May within rolled timothy leaves where they feed. Leaf margins become irregularly notched, and when the larvae are abundant, they defoliate timothy and other grasses such as orchardgrass, perennial rye grass, meadow fescue, etc. They will also feed on leguminous plants when other food is scarce.

Heavy European Skipper infestations will result in decreased yields of timothy. Fields should be checked for the presence of these caterpillars in late May or early June, when leaves are first rolled into tubes. If extensive damage occurred in the year previous, or if there are 65 or more caterpillars per square meter, the field should be treated with an insecticide. During some years, early cutting will reduce the damage, and cutting hay before mid-June should help prevent build-up of the pest.

An introduced virus is providing control of the European Skipper in Prince Edward Island.

ALFALFA BLOTCH LEAF MINER is a pest of alfalfa and present in most alfalfa growing areas. Mined leaflets frequently shatter and heavy pinhole damage from feeding causes necrosis of parts of leaflets and nutritional loss.

The adult leaf miner is a small black fly which emerges in late May. It is best identified by the numerous pinhole punctures it makes in alfalfa leaflets when it feeds and lays eggs. After the eggs hatch, the developing maggots or miners feed inside the leaflets, eating away the center part and producing mines or tunnels that terminate in blotches. The maggots then drop to the soil and pupate. The insect's life cycle takes about a month to complete and there are three generations per growing season in this region.

In the first crop, damage may be reduced by early cutting, but subsequent infestations do not correspond to cutting dates.

Introduced and native parasites of the leaf miner are providing control of the pest. Chemical control is not recommended.

ARMYWORM Localized armyworm outbreaks can occur. Maintain a close watch in late June and July, especially in grass fields. Armyworms are best detected by examining crops just before sunset. At this time the caterpillars are often visible on the plants.

Control consists of either cutting the crop immediately or chemical control (See Publication 100A). Use of chemical control may limit the use of the forage — always read the label.

FOR SPECIFIC RECOMMENDATIONS ON INSECTICIDES REFER TO PUBLICATION 100A.

Diseases

All forage legumes and grasses grown in the Atlantic Region are susceptible to diseases. The prevalence of diseases depends on many factors, including the presence of sources of infection as well as favorable temperature and moisture conditions.

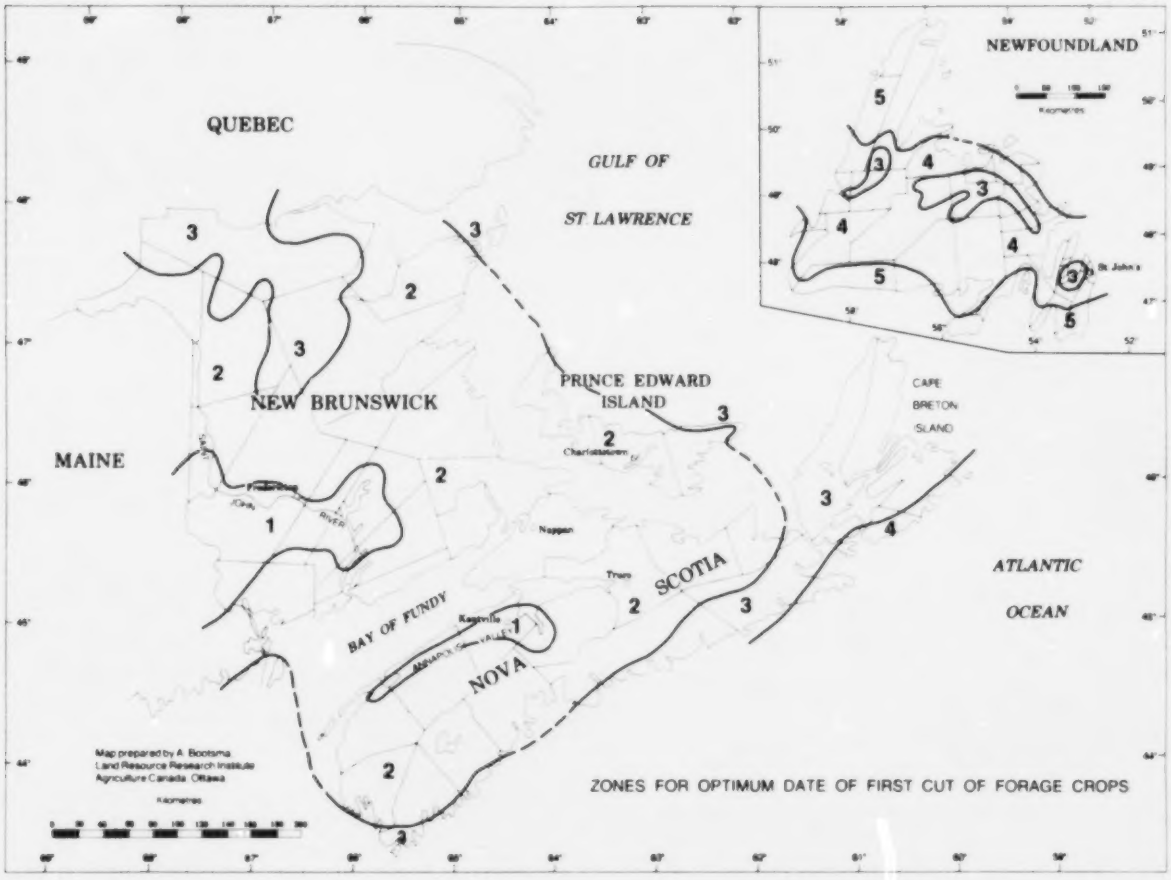
Legume Diseases — Some of the diseases which affect one or more forage legume crops in the Atlantic Region include root and crown rots, common leaf spot, black stem, downy mildew, powdery mildew, northern anthracnose, sooty blotch, clover phyllody and nematode diseases.

Verticillium wilt of alfalfa has been identified in various locations in Atlantic Canada. Verticillium wilt is a serious disease because of its potential to reduce alfalfa plant populations and thereby the quality and quantity of forage harvested. Verticillium wilt is spread by sowing contaminated seed or by moving infected plant parts from one field to another on harvesting equipment. Long term control of this disease can be achieved through the use of alfalfa cultivars which are semi-resistant to the effects of the verticillium organism. Semi-resistant cultivars suitable for use in the Atlantic Provinces are listed in Publication 100A Field Crop Variety Guide.

Grass Diseases — Brown stripe, eyespot and brown spot are a few of the diseases affecting forage grasses in the region. Each disease is caused by a different organism and the symptoms differ ranging from decayed roots, to spots on the stems and leaves, to replacement of flower petals by leaves.

Control of diseases affecting forage crops is best achieved by prevention, and it is seldom necessary or economical to use chemicals. Good farm practices - use of resistant or tolerant cultivars when available, crop rotation, crop sanitation, and recommended cultural practices - help reduce the incidence of disease. Delayed cutting is the management factor which is most serious in the build-up of diseases on forage crops.

Figure 7 — Optimum date for first cut.



AVERAGE OPTIMUM DATES FOR FIRST CUT IN POSTSEEDING YEARS

Climatic zone	Very early Orchardgrass Bromegrass	Early Early timothy Reed canarygrass Flemish (early) alfalfa	Medium Medium timothy Double cut red clover Alsike clover Standard (medium) alfalfa	Late Late timothy Single cut red clover Birdsfoot trefoil Perennial ryegrass
1	June 1-8	June 6-13	June 11-18	June 15-22
2	June 9-16	June 14-21	June 19-26	June 23-30
3	June 17-24	June 22-29	June 27-July 4	July 1-8
4	June 25-July 2	June 30-July 7	July 5-12	July 9-16
5	July 3 or later	July 8 or later	July 13 or later	July 17 or later

Harvest Management

Harvesting should be timed to maximize forage yield and quality while assuring stand survival over a period of years.

Maximum quality is obtained if the crop is harvested when the legume portion is at the bud to 10% bloom stage. Cutting at this stage allows for the harvest of three crops per season before September 1 in some parts of the Maritimes. Increases in quality feed as a result of a three cut system must be balanced against additional harvest costs compared to a two cut system and possible reductions in stand longevity.

When the entire forage crop on a farm is planted to one crop or mixture, the crop must be cut within a week to get top quality feed. To increase the period of time that forage crops are at the desirable stage of growth, a range of species or cultivars can be planted. Select the legumes on the basis of maturity, (see Publication 100A), and match the grass (species and cultivar) to the legume. Keep in mind the length of time to harvest all the forage on a farm, the soil, climate, and other characteristics of each field when selecting the species.

The leaves of a legume forage crop contain approximately 70% of the protein. It is important that they not be lost during harvest. Cutting with mower-conditioners, tedding soon after cutting and harvesting as silage are all methods which reduce potential leaf loss. For hay systems, raking at or near 40% moisture content and baling at slightly higher

moisture levels (i.e. 25% moisture) plus the use of effective preservatives or barn dryers are methods to reduce leaf shattering. Windrow inverters are capable of moving and inverting windrows of nearly dry forage with little leaf loss to improve drying.

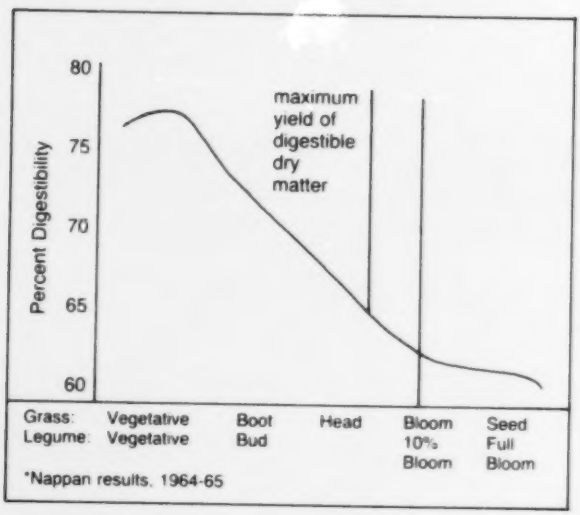
Fall Management

Legumes and grasses store food reserves in the fall. These reserves are stored as starch in the roots and are used as the winter energy supply and to provide the energy for spring growth. High levels of stored reserves are required to make the plants resistant to winter temperatures.

Root reserves are accumulated and stored in the fall during a period called the CRITICAL FALL HARVEST PERIOD, (see map). Cutting during the critical fall harvest period lowers root reserves, weakens plants, and increases the chance of winterkill.

For long life of perennial stands, and for the fastest growth the following spring, do not cut or graze alfalfa or other perennials after the critical date in your area (Figure 10).

Figure 8 — Effect of maturity on digestibility of timothy, bromegrass, orchardgrass and alfalfa*



*Nappan results, 1964-65

Figure 9 — Effect of Maturity on TDN, Crude Protein, and Animal Intake

Stage of Growth	TDN** (%)	Crude Protein (%) Grass	Legume	Intake Value (kg/100 kg body wt.)
Vegetative	63	15.2	21.0	3.0
Bud	57	11.3	16.4	2.5
Bloom	50	7.5	11.5	2.0
Mature	44	4.1	7.3	I.5
Regrowth	52	11.3	16.1	2.6

** Total digestible nutrients

Pasture Management

Good pasture is the result of good management of both the forages and the animals.

Grazing management plays a role in optimizing forage yields, maximizing longevity of improved pasture species and maintenance of sward quality. Pasture species benefit from short periods (one to several days) of heavy grazing followed by a recovery period to provide regrowth. The recovery period will vary through the season but on average will be twice as long by August 1 as it is on June 1. Pasture legumes like white clover and birdsfoot trefoil are a valuable feed component and thus the pasture should be managed to ensure their survival.

Although recently seeded pastures with improved forage species will give the greatest yield response to applied fertility, the yield of older permanent pastures can often be increased by applications of fertilizer or manure.

Annual crops such as kale, rape, stubble turnips and ryegrass produce high quality grazing during the middle and latter parts of the grazing season. Further information on annual forage crops is presented elsewhere in this publication and in other publications available from your Crops Specialists.

Forages for Soil Improvement

The rotation of crops on land in a more or less regular order or sequence is a practice that should be adopted by all farmers. Forages fit well into such rotations because they improve soil structure, reduce soil erosion, break insect and disease cycles, and will add organic matter to the soil. If a legume is used further benefit will come from nitrogen fixed by the legume.

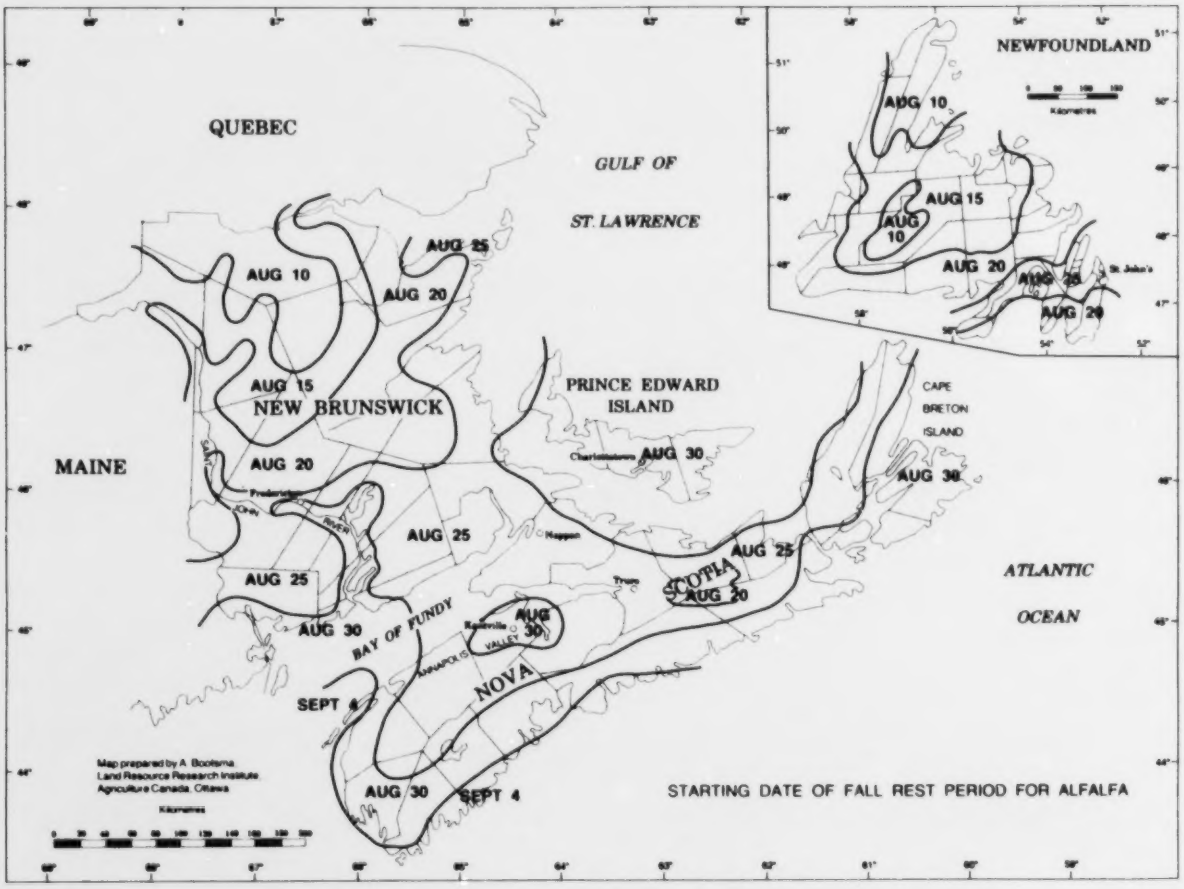
Alfalfa is a good rotation crop where a long term productive forage is required and where conditions such as good soil drainage and soil pH of 6.0 or greater is maintained. Red clover, usually mixed with timothy, is another good break or rotation crop especially where soil conditions are not suitable for alfalfa production. Sweet clover is another legume which may be beneficial in improving soil structure due to its potential to develop a deep tap root. However, sweet clover is less suited for forage production than either red clover or alfalfa.

Annual ryegrass is also a useful crop to control soil erosion, add organic matter and improve soil structure. Annual ryegrasses are poor hosts for the root lesion nematode and are not hosts for the clover and northern root knot nematodes, so growing the ryegrasses in rotations may alleviate these pest problems. As a late season pasture or cover crop, Italian type annual ryegrass can be underseeded to cereal crops. Ryegrasses may also be direct seeded in the spring to provide pasture and/or silage. If silage is to be harvested, a Westerwolds type annual ryegrass should be sown. Additionally, ryegrasses can be sown until early August for erosion control. The establishment of summer seedings may be hindered by lack of soil moisture.

Root mass of various species in the top 15 cm of soil in the year of seeding, Charlottetown data.

	Tons dry root mass per ha
Italian ryegrass, Lemtal	3-5
Italian ryegrass, Maris Ledger	3-5
Westerwolds ryegrass, Promenade	3-5
Westerwolds ryegrass, Aubade	2-3
Red clover	1.5-2.5
Alfalfa	1.5-2.5
Barley	0.5-1.0

Figure 10 — Starting date of critical harvest period of alfalfa



Perennial Forage Species

Choosing a Mixture

A good forage program begins with selection of the proper legume and grasses to suit conditions under which the mixture will be grown. Simple mixtures using one legume and one or two grasses are recommended as they are more productive than more complex mixtures. In a complex mixture, the competitive strength of the species is often not related to the forage yield. Strong competition from a low-yielding species will depress the total yield of the stand. Use of more than three species in a mixture will depress yield, even if the species are matched for competitive ability. Pure seedings of a legume or grass are recommended only when field conditions are well suited for the species and the farmer has experience growing the crop.

Choose the legume first. Legumes are beneficial as they contain more protein than grasses and they improve the soil by fixing nitrogen. Including legumes in the rotation makes this fixed nitrogen available to subsequent crops as well as improving soil structure and increasing organic matter. The legume chosen is determined by the drainage, winter hardiness, intended use, and required duration of stand required. Fertility and pH can be improved to suit the species. Choose the grass to complement the legume from the list of recommended mixtures. Choose specific cultivars for the mixture on the basis of heading or flowering date. Legumes should reach first flower when the grass starts to head to ensure maximum yield and quality at harvest (see Publication 100 A). Legumes in pure stand or mixtures must always be inoculated with the proper species of bacteria.

Alfalfa *(Medicago sativa)*

Alfalfa is the highest yielding perennial forage available in the region. Alfalfa/grass mixtures are best used for stored and green feeding, as pasturing alfalfa shortens the life of the stand and risks bloat. Alfalfa fills an important role in crop rotations, improving soil structure and building soil nitrogen fertility for future non-legume crops.

Alfalfa is a deep-rooted crop that will live for several years on well drained soils, but will suffer decreased yields and persistence on poorly drained soils.

Alfalfa needs a well-limed soil; top performance will be achieved on soils limed to a pH of 6.5 or greater. Low pH results in poor yields and short life of the stand. The pH must be increased before planting and maintained with further applications of lime.

Alfalfa must be properly inoculated with the correct bacteria to take advantage of the nitrogen-fixing ability of legumes. Balsac strain alfalfa inoculant is the most effective in the region.

Two types of alfalfa are available; Flemish and Standard. Flemish varieties flower earlier, have faster and greater yielding regrowth, but are less hardy than Standard types. Both Flemish and Standard types should be used on farms to stagger harvest dates.

The life of alfalfa under good field conditions varies from two to five years. Long life can be expected when two cuts are taken as stored feed, but a shorter life span will be found if the field is cropped three times or grazed.

Alfalfa can be grown alone or mixed with grasses. Addition of a grass to an alfalfa stand often reduces heaving, icing, and lodging of alfalfa while slowing weed encroachment and providing assurance of forage production when there is severe winterkill of legumes.

Figure 11 — Recommended Haylage Mixtures

A. Light Soils with good surface and internal drainage

Mixture	Rate	Comments
80% Alfalfa 20% Timothy	15 kg/ha	This high yielding, high quality mixture is suited to well drained soils with high pH's and good fertility. The fibrous roots of the timothy improves resistance to frost heaving.
65% Alfalfa 35% Orchardgrass	17 kg/ha	The regrowth of orchardgrass is much quicker than timothy regrowth and therefore is well adapted to a three cut system. Select an early alfalfa cultivar.
55% Alfalfa 45% Bromegrass	20 kg/ha	This mixture should be used on well drained fields and with early type of alfalfa. Bromegrass is very nutritious and productive.

B. Variable Soils-fields with both imperfectly and well drained areas

Mixture	Rate	Comments
50% Alfalfa 30% Red clover 20% Timothy	12 kg/ha	Consider sowing this mixture in the fields where soil type is variable and not totally suited for alfalfa.
30% Alfalfa 15% Red Clover 5% Ladino Clover 50% Timothy	15 kg/ha	For fields containing soils with variable drainage. Formed dykeland as an example.

C. Imperfectly Drained Soils - Heavy Land Mixtures

Mixture	Rate	Comments
60% Red Clover 40% Timothy	12 kg/ha	Best suited for short rotations. Contains a high percentage of Red Clover in the first two production years as the red clover thins out, both yield and quality decline.
40% Red Clover 18% Ladino White Clover 42% Timothy	12 kg/ha	The addition of White Clover improves the quality and persistence of legumes in the field. Not suitable for hay due to difficult wilting characteristics of white clover.
30% Red Clover 10% Ladino White Clover 40% Timothy 20% Meadow Fescue	20 kg/ha	The additional grass improves the reliability and the longevity of this mixture.

Figure 12 — Recommended Hay Mixtures

A. Moderate to Well Drained Soils

Mixture	Rate	Comments
65% Alfalfa 35% Timothy	15 kg/ha	Although alfalfa is not as difficult to wilt as red clover, a hay drier will allow baling at higher moisture improving leaf retention.
50% Alfalfa 50% Bromegrass	20 kg/ha	Select an Early type of alfalfa. Bromegrass is superior to timothy in quality and regrowth.
60% Alfalfa 40% Orchardgrass	17 kg/ha	Select an Early type of alfalfa. This mixture is well adapted to three cuts. Orchardgrass has excellent regrowth potential but matures very early; therefore, the first cut should be harvested as haylage.
Orchardgrass	11 kg/ha	Three cuts are possible. Heads out in late May/early June; therefore, plan to use first growth for pasture or haylage.
Bromegrass	15 kg/ha	This species is well adapted to deeper droughty soils. Due to early maturity, plan to take first cut as haylage. When seeding in late spring or early August, a grain drill will give better results.

B. Poor and Imperfectly Drained Soils

Mixture	Rate	Comments
30% Red Clover 70% Timothy	12 kg/ha	Red clover is difficult to field cure. A hay drier will help prevent heating in the mow. Red clover is a short lived perennial which cannot be expected to produce longer than three years.
25% Red Clover 75% Reed Canarygrass	15 kg/ha	By the third production year mixture will be predominately Reed Canarygrass which is adapted to a wide variety of soil types and will even tolerate periodic flooding. Select low alkaloid varieties of Reed Canarygrass.
Timothy	10 kg/ha	Straight timothy should be considered on farms without hay driers and/or in coastal areas that are subjected to difficult drying conditions. Select varieties with varying maturities to spread out the harvest season.
Reed Canarygrass	12 kg/ha	Low alkaloid varieties of Canarygrass can be used on farms without hay driers or on extremely poorly drained fields which are subjected to periodic flooding. The quality and palatability declines rapidly following heading.

Figure 13 — Recommended Perennial Pasture Mixtures

A. Well Managed Controlled Grazing System

These mixtures are designed with careful consideration to the specific attributes of each species. Larger, erect, easily defoliated species with quick regrowth are best suited for rotational grazing and conservation. Close attention must be paid to fertility levels, stocking rates and rotational grazing practices if the following mixtures are to remain productive.

Moderately Well to Well Drained Soils

Mixture	Rate	Comments
White Clover 30% Orchardgrass 70%	10 kg/ha	A good dual purpose mixture for early cut silage and early rotational grazing. Must be managed well, if underutilized will become stemmy. Subject to winter killing.
White Clover 10% Orchardgrass 30% Perennial Ryegrass 60%	22 kg/ha	Very palatable mixture. Caution: perennial ryegrass lacks winter hardiness. Consideration must be given to winterkill susceptibility.
White Clover 10% Orchardgrass 30% Meadow Fescue 60%	22 kg/ha	Dual purpose mixture for early cut silage and rotational grazing. Meadow fescue helps give a better bottom to the pasture producing a tighter sod, more resistant to punching.

Imperfectly Drained soils

Mixture	Rate	Comments
White Clover 10% Timothy 25% Meadow Fescue 65%	20 kg/ha	Late flowering timothies are better adapted to grazing.
White Clover 10% Orchardgrass 30% Meadow Fescue 60%	22 kg/ha	Dual purpose mixture for early cut silage and rotational grazing.
White Clover 10% Orchardgrass 30% Fescue hybrid 60%	22 kg/ha	The fescue hybrid will become coarse by 3rd production year reducing palatability. Best suited for rotationally grazed beef cow pastures.

Imperfect to Poorly Drained Soils

Mixture	Rate	Comments
White Clover 10% Timothy 25% Fescue Hybrid 65%	20 kg/ha	The fescue hybrid will become coarse by 3rd year reducing overall palatability. Best suited for rotationally grazed beef cow pastures.
White Clover 10% Timothy 35% Reed Canary Grass 55%	16 kg/ha	Reed Canary Grass slow to establish, but once established is very perennial. Can be cut for silage and the aftermath grazed.

B. Traditional Non Intensive, Continuously Grazed Pastures

Continuously grazed pastures should be stocked about twice as heavily in spring than in mid-summer. This will improve leafiness of the pasture and reduce spring wastage. Species in the following mixtures are shorter and semi-prostrate and therefore better adapted to continuous grazing.

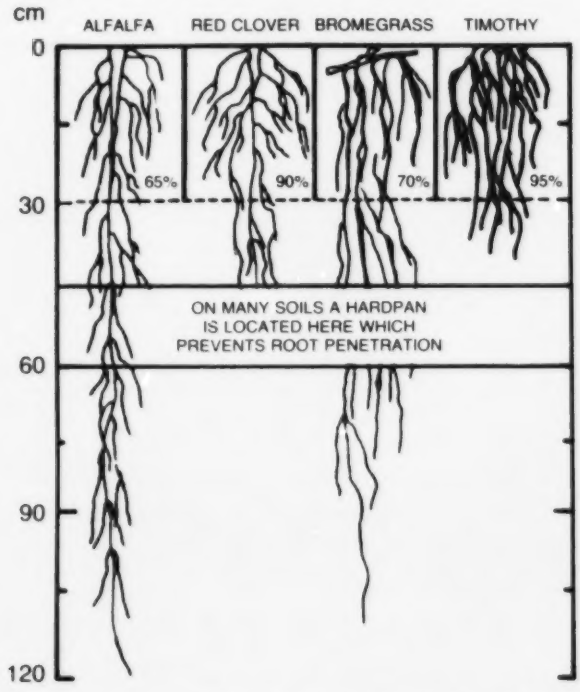
Moderately Well to Well Drained Soils

Mixture	Rate	Comments
White Clover 10% Kentucky Bluegrass 40% Perennial Ryegrass 50%	22 kg/ha	Caution: the Perennial Ryegrass lacks winter hardiness. Consideration must be given to winterkill susceptibility. Mixture unproductive under dry conditions.

Well Drained to Poorly Drained Soils

Mixture	Rate	Comments
White Clover 15% Timothy 30% Kentucky Bluegrass 55%	18 kg/ha	Very palatable, however, subject to drought stress. Lacks productivity in mid summer.
White Clover 10% Kentucky Bluegrass 30% Creeping Red Fescue 60%	22 kg/ha	This mixture can become sod bound. Requires good fertility. Limited regrowth in mid season.

Figure 14 — Rooting Depth in Soil



Alfalfa and bromegrass have deep root systems with only 65 and 70% of their roots in the top 30 cm of soil. Red clover and timothy have 90 and 95% of the roots in the top 30 cm of soil. Because of this deeper root system, alfalfa and bromegrass are more productive on light textured soils which tend to dry out rapidly.

Red Clover *(Trifolium pratense)*

Red Clover is a biennial or short-lived perennial. It is more tolerant to low pH and variable drainage than alfalfa. Red clover yields well in the year following seeding. Red clover is difficult to make into hay and is more easily managed as haylage. Timothy is the best grass to mix with red clover for stored feed mixtures. It is not recommended in pasture mixes as it has a short life and does not tolerate grazing well. Red clover should not be included in alfalfa/grass mixtures as it competes severely with the alfalfa during the seeding year resulting in a thin stand of alfalfa after the red clover dies out.

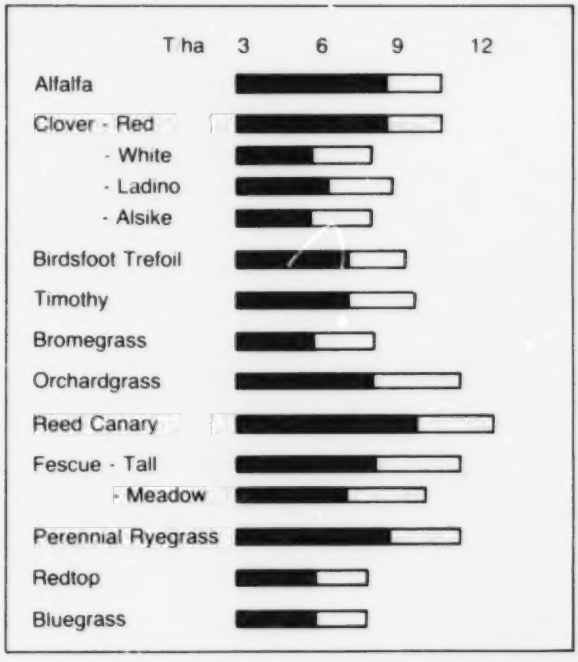
Red clover is available as double cut (D.C.) or single cut (S.C.) types. Double cut red clover reaches the cutting stage about ten days before single cut and has a stronger, more vigorous regrowth. Red clover makes an excellent plough-down or green manure crop. If direct seeded in early spring of a favorable year, red clover will produce a four tonne/hectare hay crop in late July and a further two tonne of top growth and two tonne of roots by late fall. Best results are obtained when the red clover is inoculated with the proper species of Rhizobium bacteria.

White Clover *(Trifolium repens)*

White Clover is first and foremost a pasture species and is the most important pasture legume in Atlantic Canada supplying significant amounts of palatable nutritious grazing. Due to its low growth habit and its ability to decrease the risk of bloat, white clover is frequently included in pasture mixtures with orchardgrass, fescues, perennial ryegrass or reed canarygrass.

There are three basic types of white clover classified on the basis of leaf size. The small leaved white clovers are typified by "wild" or naturalized white clovers found in many older pastures. The small size of these plants restricts their forage production but these types are very persistent particularly under continuous grazing.

Figure 15 — Potential Yield of Perennial Forage Species under Good Management



The intermediate type is typified by the cultivars Sonja and Milkanova. White clovers of this class are included in improved pasture mixtures because they show superior forage production and nitrogen fixation compared to "wild" types.

The third classification of white clovers is typified by the large leaf or Ladino type clovers. Ladino type clovers are more productive but are frequently shorter lived than either the wild or intermediate type clovers. They are only recommended in haylage mixtures particularly on soils with variable drainage. This legume is very difficult to wilt properly for hay.

Whenever white clover is included in a pasture or pasture seed mix, management plays a key role. Close grazing with adequate recovery periods and fertile soil conditions provides excellent conditions to maintain the percentage of white clover in the sward.

Birdsfoot Trefoil *(Lotus corniculatus)*

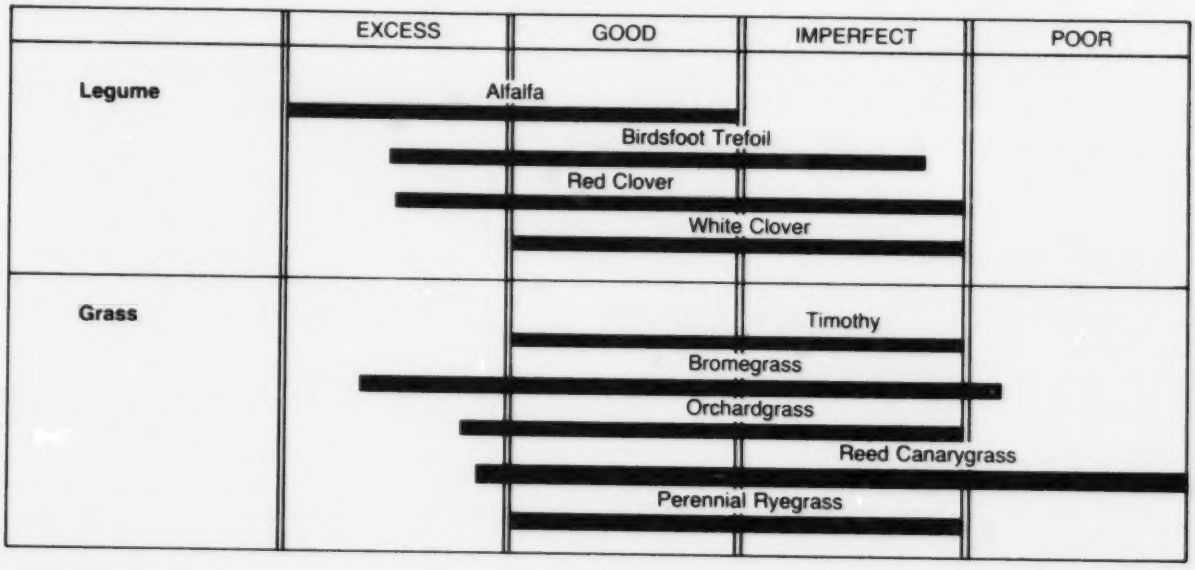
Birdsfoot trefoil can be difficult to establish in some areas of the Atlantic Provinces. This species does not compete well with grasses and weeds, nor does it persist well under intensive grazing. When successfully established however, trefoil will often perform better than other legumes in areas of low fertility and under poor drainage.

Trefoil based mixtures can be used for pasture, stored feed, or green chop, and under proper management can have a long life span. Trefoil is well adapted to pasturing

as it does not cause bloat, and is a good legume for fields that are difficult to plow and reseed. Trefoil should not be grazed until 25 to 30 cm high in the spring. For best result use rotational grazing to prevent the animals from grazing the stand too low. Trefoil requires the same fall rest period as alfalfa. Yields will be reduced in succeeding years if trefoil is harvested or grazed during the critical fall harvest period. As a stored feed, trefoil matures later than other legumes and maintains feed value well.

Trefoil is slow to establish and does not tolerate shading in the seedling stage. Direct seeding gives best results if good weed control is practiced. If trefoil is underseeded to cereals, the cereal should be seeded at not more than 50 kg/ha and removed early as green chop. Trefoil must be inoculated with the correct Rhizobium bacteria for maximum yield.

Figure 16 — Drainage Requirements of Forage Crop



Alsike Clover *(Trifolium hybridum)*

Alsike is a medium height clover with smaller leaves and flowers than Ladino. Alsike will grow on wet, acid soils but will not grow on dry soils or during hot weather. Yields can be good under high fertility and even rainfall distribution, but are not consistent from year to year. The addition of alsike to mixtures often lowers overall yield after the establishment year because it is very short-lived. It is therefore not recommended in perennial mixtures, but may have potential if combined with annual ryegrass.

Sweet Clover *(Melilotus alba)*

Sweet clover is a tall, bush-like, coarse legume. The main use of sweet clover is for soil improvement as it has a deep tap root and will grow under adverse soil conditions but requires a good pH. It is not recommended for feed as it contains coumarins which may cause "sweet clover bleeding disease" in livestock. Low coumarin cultivars do not survive Atlantic Region winters.

The seed coat of sweet clover is very hard and requires scarification before planting. Most seed of commerce is scarified when purchased. The proper strain of Rhizobium bacteria must be used when inoculating of this legume.

Timothy *(Phleum pratense)*

Timothy is widely adapted, easy to establish and maintain, and compatible with all legumes. When cut at the boot to heading stage, it is a good forage for all classes of livestock. Good second crops can be obtained if the first crop is removed at the heading stage and before bloom appears. Timothy contains about half the crude protein of alfalfa and has less regrowth than bromegrass or orchardgrass. It may have difficulty surviving in alfalfa fields under a three cut system. Timothy added to a legume mixture provides insurance against loss of forage production during a year in which legumes winterkill.

Timothy will grow on acid, wet soils but both yield and quality are improved when grown on well drained soils where both lime and fertilizer are added. Since it has a shallow root system, regrowth is slow in hot dry weather.

Cultivars are available in a range of maturities so that the harvest periods can be spread out while maintaining optimum quality.

Bromegrass *(Bromus inermis)*

Smooth bromegrass is an excellent companion for alfalfa in a hay or haylage system. Bromegrass has early maturity, good yield, and regrowth, especially on droughty soils. It forms a strong sod and fills in as the alfalfa thins out. Bromegrass provides excellent regrowth in a two cut system but may have poor persistence in a three cut system.

Bromegrass has a deep root system and requires deep, well drained soils. It spreads by short rhizomes and requires high amounts of nitrogen if grown as a pure stand or after alfalfa has thinned out of a mixture. Bromegrass provides early pasture and will regrow to provide good late pasture.

Orchardgrass *(Dactylis glomerata)*

Orchardgrass is a very early aggressive species which can be used for stored feed, green chop, or pasture. Because of a late May to early June heading date, and rapid regrowth, it should be seeded alone, or with aggressive legumes such as a Flemish alfalfa or Ladino clover. Orchardgrass must be cut just as heads emerge from the boot as quality decreases rapidly after heading.

Orchardgrass requires well drained soils to give top yields. Surface drainage is necessary as ice or flooding will kill orchardgrass.

In some cases, heavy applications of nitrogen fertilizer in the spring may help orchardgrass to recover from winter injury but in general orchardgrass should be limited to well drained soils.

Figure 17 — Harvest Method Suitability of Perennial Forages

	Conserved Forage	Rotational Grazing	Continuous Grazing
Alfalfa	●	ø	ϒ
Clover - Red	●	○	ø
- White	○	●	ø
- Ladino	○	●	ø
- Alsike	●	●	ø
Birdsfoot Trefoil	●	●	ø
Timothy	●	○	ϒ
Bromegrass	●	○	ø
Orchardgrass	●	●	○
Reed Canary	●	●	○
Fescue - Tall	●	●	○
- Meadow	○	●	●
Perennial Ryegrass	●	●	○
Redtop	ø	●	●
Bluegrass	ø	●	●

● Highly suitable
○ Suitable
ø Not recommmended corp will tolerate
ϒ Crop damage

Meadow Fescue *(Festuca pratensis)*

Meadow fescue, a perennial bunchgrass that grows 35 to 75 cm tall, is adapted to the same climate and soil as timothy but yields best on deep rich soils. It will tolerate wet soils with proper care and fertilization. Meadow fescue is a good grazing grass and is used primarily for pastures, generally in mixtures. It can be used as a stored feed if seeded in mixtures using timothy, orchardgrass and legumes. Meadow fescue has increased in popularity over the past few years because of its versatility, tolerance to variable drainage and its ability to regrow better than timothy during the mid-summer period.

Perennial Ryegrass *(Lolium perenne)*

Perennial ryegrass is a high quality forage that makes an excellent pasture for grazing animals. It is a very rapid growing species that requires fertile soil, ample moisture and a relatively mild climate.

Perennial ryegrass is a bunchgrass with a relatively shallow root system which can make it quite unproductive during hot weather if moisture is limiting.

The high nutritive value of perennial ryegrass and fast establishment makes it an excellent addition to a pasture mixture.

Due to the susceptibility of currently recommended perennial ryegrasses to winter injury, it is advised that this grass not be the main grass of a mixture, except where relatively mild winter conditions exist.

Reed Canarygrass *(Phalaris arundinacea)*

Reed canarygrass is a tall, wide leaved plant. It will tolerate excess moisture (even flooding) and low pH, but produces high yields on well drained, fertile soils. Reed canarygrass loses quality extremely rapidly after heading. If grazed heavily enough or cut sufficiently often to prevent heading, it makes good quality, high yielding forage.

Low intake and lack of palatability in reed canarygrass have been associated with mildly toxic alkaloids contained in the plant. Recent plant breeding work has produced several new varieties with low alkaloid contents and improved animal acceptability.

Seed of this crop does not retain its germination in storage as well as most other grasses. Carry-over seed should not be planted without first having it tested for germination.

Tall Fescue *(Festuca arundinacea)*

Tall fescue is a deep-rooted, long-lived perennial, tolerant to imperfect drainage, adapted to most soils, and resistant to trampling. It is basically a bunch grass but frequent mowing or grazing will produce an even sod.

Tall fescue is adapted to pasture, or stored feed. Both palatability and quality is improved if the fescue is cut early and grazed heavily. Fescue makes a good fall pasture as growth is adequate and quality is maintained at that time of year. New cultivars of fescue and fescue-cross hybrids may improve livestock acceptance of this productive grass.

Redtop *(Agrostis spp.)*

Redtop is a perennial grass with fine leaves and stems which forms a loose sod. Redtop will grow on low fertility, acid, and poorly drained soils but yields are low. Redtop is ready for grazing about the same time as timothy. Quality is less than bluegrass grown under similar conditions, and yield is lower. The major use of redtop is pasture mixes but it can be used for stored feed on poor soils.

Redtop is often included in mixtures for ditch banks and grass waterways to prevent erosion.

Bluegrass *(Poa pratensis)*

Bluegrass has a dense shallow root system and produces lush palatable growth. Bluegrass grows in the spring and is stockpiled for pasturing in the summer. Canada bluegrass maintains quality better than Kentucky bluegrass for summer feeding. Pasture production could be improved through improved management. Yield of pure stands of bluegrass do not warrant harvest as stored feed although quality can be good.

The dense root system and creeping growth habit make bluegrass an option as a bottom grass in horse pastures and to provide protection against erosion of banks.

Creeping Red Fescue *(Festuca rubra)*

Creeping red fescue is a low growing creeping grass that spreads vigorously. On ditch banks, terraces, or steep slopes, the roots hold the soil while the thatch of top growth slows water movement and protects the soil surface.

Creeping red fescue can be established on most soils with good fertility. It makes a good addition to pasture mixes as a "bottom-grass" as it tolerates heavy animal traffic.

Annual Forage Crops

Most of the forage in the region is currently supplied by perennial legumes and grasses. Annual crops can be used to supplement perennial forage crops or as emergency crops to provide forage after winterkill of perennial crops.

The major use of annual forages is high quality feed production during the critical fall harvest period of legumes. When selecting an annual crop, one must consider the cost of working the land, the time of year the annual forage is produced, the yield and the end use of the forage. Annual forage crops work well in rotation with perennial legumes.

Persian Clover *(Trifolium resupinatum)*

Persian clovers act as an annual under Atlantic Canadian conditions. It is well adapted for inclusion in mixtures of annual ryegrass for pasture or silage. Proper inoculation is required as this is a new clover for this region.

Italian and Westerwolds Ryegrass *(Lolium multiflorum)*

Italian and Westerwolds ryegrasses seeded early in the spring will provide high quality forage from mid-July to late fall. Ryegrass should be seeded at 15-35 kg/ha and fertilized at seeding, in July, and in August for maximum yields. Nitrogen in particular is essential for high yields. Italian ryegrass is suitable for pasture, while Westerwolds ryegrasses may be used for stored feed and pasture.

Corn *(Zea mays)*

See Corn section of this publication.

Cereals

Cereals, either winter or spring, can be utilized for supplemental grazing or harvested as a silage crop.

Grazing

Spring cereals can be seeded from early spring until late August to provide grazing approximately six weeks from planting. Winter cereals seeded in late summer can also provide some fall grazing. Seeding winter cereal earlier than recommended for grain production could increase fall grazing at the risk of increasing disease pressure in the cereal crop. Winter cereals also may be grazed in early spring. Use of cereals as a grazing crop is usually more expensive than using annual crops such as ryegrass, kale, rape or permanent pasture.

Silage

Cereals are easily ensiled since water soluble carbohydrate levels are high, buffering capacity is low and moisture content is easily controlled. Since quality, especially protein content is relatively low, cereals should be harvested before they get too mature. Maximum total yield and total protein is obtained by harvesting at or before the soft dough stage.

Forage crops are frequently undersown with a cereal cover crop. Harvesting the cereal as a silage crop reduces the chance of forage stand damage due to the cereal lodging. Early removal of the cereal crop as silage will also provide a longer fall growing period for the new forage crop.

Green Fodder Crops

Green fodder crops encompass the forage brassicas such as kale, rape and stubble turnips plus fodder beets. These crops provide superior late season supplementary grazing due to their excellent yields and maintenance of feed quality. These crops also represent a viable way of extending the grazing season into the late fall. Forage brassicas require strip or small paddock grazing for maximum utilization.

Extensive cultivar evaluation has been carried out in this region and the following species can be recommended.

Kale *(Brassica oleracea)*

Kale requires a long growing season for the crop to fully develop (90-100 days). It is frost hardy making it suitable for grazing up to December.

Forage Rape *(Brassica napus)*

Rape grows faster than kale and produces a leafy crop for late season consumption. Feeding rape to milking cows may taint milk.

Stubble Turnips *(Brassica rapa)* **and Hybrids**

Stubble turnips are fast-growing, with large leaves and a root bulb. About 3/4 of the root bulb is above ground and is readily grazed by livestock. The hybrids are more leafy but have no, or very small, root bulbs. The hybrids are also suitable for green manuring.

Fodder Beets *(Beta vulgaris)*

Fodder beets are a high yielding crop with a high energy content. A large portion of the production of this crop is contained in the root. Successful utilization of this crop can be achieved through grazing or by harvesting the bulb for storage. Approximately 4-6 kg of fodder beet can replace 1 kg of rolled barley.

Further information on the above crops is available from your local crops specialists.

Corn

Introduction

Corn is an important high yielding and high energy supplement for livestock feed in the Maritime Provinces. With the continuing introduction of new, earlier maturing corn hybrids, and a number of different options of harvesting and storage methods to choose from, more farmers should look to both silage and grain corn as home-grown animal feed sources.

Corn Production Options

Whole Plant Silage

The relatively cool growing season in some parts of the Maritimes makes corn silage a choice of many farmers. Silage corn will consistently produce more total digestible nutrients per unit area than other locally-grown forage crops. Good quality silage is highly palatable, and very high in energy. Corn silage is an excellent feed for all classes of dairy and beef cattle, combining well with high protein forages in the diet. However, corn harvested as silage leaves fields with little stubble and thus may substantially contribute to soil erosion, which makes field choice an important consideration.

High Moisture Corn

The production of high moisture corn has really increased over the past five years, particularly in Nova Scotia. High moisture corn has been grown by dairy and beef farmers who have adequate fibre and protein supplies from high quality forages, and are looking to high moisture corn as a very good energy supplement.

From a soil conservation point of view, high moisture corn on sloping or sandy soils leaves the stalks in the field to reduce soil erosion and help maintain soil fertility and organic matter.

The term "high moisture" corn refers to either grain or whole ears harvested and stored at a high moisture content; 24 to 33% moisture for shelled grain and 25 to 40% for whole ears.

High Moisture Shelled Corn — the grain is shelled from the ear and ensiled in a well-managed, oxygen limiting silo to provide feed for both cattle and hogs.

High Moisture Ear Corn — Two harvest methods are available. A forage harvester can be equipped to pick and chop the ears which are then blown into the silo with a regular blower. Also a corn picker or combine can be used to harvest the corn, which is then ground at the blower. This grinding step is essential in all concrete upright silos, bunker silos, and piles of earcorn stored on a slab, to ensure proper packing, air exclusion and ensiling results. Grinding of "combined or picked corn" as opposed to corn that has been harvested with a snapper head-forage harvester, can be accomplished at the silo by putting the corn through a forage harvester with the proper screens in place, or a commercial portable roller or hammer mill/blower combination especially designed for this purpose.

The feed value of high moisture ear corn is similar to cribbed ear corn, however, it can be harvested and stored at a higher moisture content than corn for cribbing.

Cribbed Ear Corn

Cribbed ear corn is not a popular production option in the Maritimes because the damper winters can cause corn deterioration in storage and also due to the laborious task of filling, unloading and processing cribbed corn.

This method of harvesting consists of picking the ears, and placing them in a crib or in a well ventilated bin for storage. In general, cribs must be less than 1 meter wide to allow air to circulate completely through the corn. An exposed windy site is preferred. The cribbed corn must be less than 35% moisture at harvest and all husks, silks and trash must be removed to prevent blocking of air flow through the corn.

Whole ears ground as meal are a suitable feed for both dairy and beef cattle with an energy content only slightly less than that of grain corn.

Dried Shelled Corn

Shelled grain corn is being produced in only a few more favourable corn growing areas of the Maritimes. Artificial drying of grain to 15% moisture is necessary for safe storage. Shelled grain corn is a suitable feed for all classes of livestock and can be incorporated into "on farm" rations or sold as a cash crop.

To properly mature good crops of dried corn, careful consideration has to be given to field selection in terms of soil texture that allows early warm-up and planting, plus the previous crop or crop rotation (refer to next sections). As new, earlier cold tolerant hybrids are introduced, grain corn production may spread to other areas.

Climatic Requirements

Corn is a crop which is at its climatic limit in the Maritimes. Only areas with sufficient heat and a long growing season can successfully produce corn in this region. Coastal areas have a long growing season, but the cooler temperatures do not provide sufficient heat for corn to reach maturity. Corn is a heat-loving crop which requires temperatures above 10°C to germinate and grows best at high temperatures. Early planting of corn in the Maritimes is difficult as heavy rainfall can delay field work and soils are slow warming to the temperature needed for germination and vigorous growth. Good drainage helps reduce both these problems. Corn is a long season crop which must reach maturity before the fall frost. Grain corn will continue to dry down after a killing frost, but no more dry matter accumulates. It is important to select a hybrid which will mature in your area.

Corn Heat Units (CHU) are calculated from daily maximum and minimum temperatures. They provide a way of rating corn hybrids and geographic regions, thus providing a basis for selecting hybrids with a maturity rating suited to the location. Most corn hybrids have a listed CHU rating, but the rating given to hybrids in other areas does not apply in the Maritimes.

The Maritimes have been divided into zones for corn production based on the CHU available in the region, (see Publication 100A, Guide to Field Crop Variety & Pesticide Selection). The Annapolis Valley and the river valleys of south-central New Brunswick have enough CHU for consistently maturing early grain corn hybrids. These areas are designated as Zone 1. They have the greatest potential for corn; both grain and silage corn can be consistently produced.

Corn grown for silage is harvested at approximately 50% moisture in the grain, or 30-35% whole plant dry matter, before grain maturity is reached, thus requiring fewer CHU. Areas designated as Zone 2 are suitable for high moisture ear corn, cribbed corn, or silage. Areas designated as Zone 3, produce an acceptable silage with only the earliest hybrids. Areas designated as Zone 4, are risky for corn production, even for silage. Corn is not recommended for these areas.

The calculation of CHU for the various locations in the Maritimes is based on the "average" data for a 30-year period. When using this information keep in mind that half the years will be better than indicated, but half the years will be worse. When evaluating the performance of a hybrid on your farm, check the CHU accumulated that season and compare them to the long term average before making a decision.

For additional information on heat unit ratings of corn hybrids and a detailed CHU map, see "Heat Units for Corn in the Maritime Provinces", Publication ACA 90-1 (Agdex No 111.31).

Crop Planning

There are a number of key points to consider when selecting fields to grow corn.

1) With good cultural practices, successful corn crops are produced on most well-drained Maritime soil types. Choose fields with good, natural drainage or improved drainage (ditches or tile drains) for corn. Well drained soil is important for grain corn as the harvest may extend into the early winter when excess moisture affects travelling over the field. POORLY DRAINED SOILS ARE NOT SUITABLE FOR CORN.
2) Although corn is tolerant of pH readings as low as 5.5, fields should be limed to above pH 6.0 for best production and fertilizer efficiency.
3) Areas or fields that are known to have significant bird or raccoon damage can seriously affect grain yields.
4) Fields with greater than 5% slope can present serious erosion problems especially in silage corn production. If ear corn or grain corn are grown on sloping land, maintain crop residue on the surface over the winter months or practice appropriate conservation tillage.
5) Fields subject to early fall frost should be avoided where possible.
6) Fields reasonably close to the silage storage area reduce transportation time and expense. Corn silage is 65-70% water.
7) Distance to manure sources should be considered in choosing corn fields. Corn is one of the most efficient utilizers of the nutrients in manure. Spring incorporation of manure is the best method of utilization. Fields which allow early travel in the spring are an advantage.
8) Corn, along with other cereals, offers an excellent opportunity to clean fields of certain weeds. Attention must be paid to a planned approach to weed control. The potential residue effects of certain herbicides on subsequent crops and ground water quality must be understood.

Corn as a Rotation Crop

Many farmers find that corn offers advantages in a cropping rotation system beyond its yield advantage.

Some points to consider are:

1) Corn makes excellent use of manure. Large amounts can be applied without fear of lodging and as manure can be incorporated, the nutrient value is maintained for the crop.
2) Corn production allows for a break in the forage crop cycle. A sod bound condition can be broken with a year or two of corn.
3) A wide range of possible chemical and cultural weed control options are available to clean up fields for other crops such as grain or legume forages. A well designed crop rotation rotates both crops and weed control methods so no one species of weed has a chance to build up.
4) Corn production spreads the workload on many farms. It is planted later than spring cereals and harvest is a single operation later in the fall after work on other crops is finished.
5) Corn provides a high energy feed to balance the protein produced by good quality forages.

The most practical rotation usually involves 1 to 2 years of corn followed by some other crop (preferably not barley/wheat due to the fusarium head disease problems common to all three crops). Continuous corn, particularly on sloping ground leads to problems of soil degradation and ultimately erosion. Rotations with forage crops lessen this problem.

In some areas aerial seeding of all rye in mid-August has provided a suitable cover crop to reduce erosion. Excess chemical residues may reduce the growth of the rye. Fall plowing should be avoided on fields subject to erosion.

Hybrid Selection

New hybrids are continually being evaluated in the Maritimes to select very early maturing hybrids with strong stalks, high yielding ability, and resistance to insects and diseases. MANY CORN HYBRIDS ARE AVAILABLE, BUT ONLY THOSE ON THE RECOMMENDED LIST HAVE PROVEN THEIR ABILITY TO PERFORM SATISFACTORILY UNDER MARITIME CONDITIONS. SEE THE RECOMMENDED CORN HYBRID LIST PUBLISHED EACH YEAR IN PUBLICATION 100A (FIELD CROP GUIDE TO VARIETY, HERBICIDE AND PESTICIDE SELECTION) OR PUBLICATION 140, THE YEARLY CORN EVALUATION TRIAL REPORT. THESE ARE AVAILABLE FROM YOUR AGRICULTURAL OFFICE TO SELECT A HYBRID SUITABLE FOR YOUR AREA.

Choice of Silage Hybrids

Yield, maturity and lodging resistance are important considerations in choosing a hybrid for silage making. Corn reaching the dough stage, the time when most of the kernels are dented or glazed, makes the best silage. At this stage the whole plant contains 65 to 70% moisture. The highest yielding hybrid which generally reaches this stage before frost damage occurs is the best one to select. It is a common error to choose late-maturing hybrids which look attractive due to vigorous growth characteristics. Good quality silage requires that grain formation be well advanced by harvest time. Silage made at the proper moisture level will give the least amount of trouble from freezing, spoilage and silo structure deterioration.

Choice of Grain Hybrids

The most important characteristics of a hybrid for grain production are early maturity, high yielding ability, and resistance to lodging and stalk breakage. Fall frost damage can generally be avoided by choosing hybrids with a heat unit rating no greater than the heat unit accumulation indicated for the growing region. Corn that is frozen before maturity produces grain of inferior quality and requires additional expenditures to dry to a level safe for storage.

Stalk strength is important as mechanical pickers often miss ears on lodged or broken plants. Most breakage results from weakening of the stalk by stalk-rot or by corn borer infestation. Both tend to increase as the proportion of land devoted to corn increases. Stalk strength, resistance to root lodging and resistance to smut are given major consideration in breeding programs. Hybrids are rated for standability to enable the farmer to give this factor due consideration in choosing a hybrid.

Field Operations

Preparing the Seedbed

Tillage operations should produce a level friable seedbed, free of large chunks of soil. A well prepared seedbed will absorb moisture, permit aeration, and warm up rapidly, encouraging fast, uniform germination and emergence of corn seedlings. Excessive tillage should be avoided since it may lead to soil compaction, pooling on the surface and erosion. When an excessively tilled seedbed dries out following a rain, crusting and cracking of the surface layer frequently takes place, resulting in poor emergence and a reduced plant population. DEPTH OF SEED PLACEMENT IS VERY DIFFICULT TO CONTROL IN AN OVERTILLED SEEDBED, RESULTING IN UNEVEN EMERGENCE.

Tillage Equipment Selection

In recent years, several new options in tillage equipment and conservation planters have been utilized in the Maritimes. Primary tillage implements such as chisel plows or off-set disc harrows, are used on corn or grain stubble to produce quicker initial tillage results than the conventional moldboard plowing practice. The chisel plow, or off-set discs, are sometimes referred to as "conservation tillage implements". These implements can leave higher amounts of crop residue on the soil surface of sloping fields (greater than 5% slope) to minimize potential soil erosion losses. Moldboard plowing is, however, the desired method of tillage on sod land to produce a proper seedbed under these conditions and reduce annual grass weed problems somewhat.

In terms of secondary tillage implements, many farmers are relying more heavily on "S" tine harrows with rolling crumblers or roller-harrow combination units, than the traditional disc and spring tooth harrows which often left seedbeds overworked and fluffy. Disc harrows are still necessary, however, on some heavier textured soils or in fields coming out of forages. When using a disc harrow, consideration should be given to limiting the number of passes and rolling prior to planting, if necessary.

Whatever tillage system is utilized, the seedbed produced should:

- permit early planting
- maintain or improve the soil structure
- destroy weeds germinated prior to planting
- permit uniform depth and placement of seed and fertilizer
- provide conditions for rapid seed germination.

No-Till Corn

No-till corn production may never be widely practiced in the Maritimes because of slower warm-up of our cool, moist soils. However, there may be some application for no-till planting on sandier soils that may be prone to serious soil erosion losses.

No-till corn is much more popular in the higher heat unit areas of southern Ontario and parts of the U.S.. Research from the University of Guelph indicates that corn planted with zero-tillage following corn has averaged about 15% lower yield than with conventional tillage in most situations. On sandy and gravely loams or where corn has followed crops other than corn, yield differences caused by zero-tillage have been smaller. Corn yields with chisel plowing have been similar to those following moldboard plowing on sandy loam soils, but not on silt loam, clay loam or clay soils. However, where corn is grown following crops other than corn on fine-textured soils, chisel plowing has resulted in yields similar to those after moldboard plowing.

In high no-till corn acreage areas farmers use conservation planters equipped with special coulters to move surface residue out of the planting row. For any Maritime farmer wanting to attempt no-till corn, it is suggested that the regular planter be modified in the way described by Charlottetown Research Station scientist in Canadex report 111.22.

No-till corn planting can be advantageous in certain conditions. Its advantages are: reduced tillage, less time and machinery required at planting, less fuel used, and reductions in erosion. Some of its drawbacks are: not suitable on all soils, especially heavy, slow warm-up soils; difficulty in getting fertility placed throughout the plow layer; and possible build-ups of insect or weed problems. Any problems would likely intensify with the length of time no-till is practiced on a given field.

Seeding Date

PLANTING CAN BEGIN WHEN THE MID DAY SOIL TEMPERATURE HAS REACHED 10°C OR HIGHER FOR TWO CONSECUTIVE DAYS AT A DEPTH OF 3CM. Depending on location and type, soils of the Maritime area normally reach this temperature between May 7-20th. Planting corn in a soil that remains below 10 °C for 8 to 10 days can result in seed rot, insect damage to seed, delayed germination, and irregular emergence. Corn planted later than the first week of June is unlikely to produce satisfactory yields or maturity levels. Early planting usually results in greater maturity at harvest, even if no yield increase occurs.

Early Seeding of Corn Results in:

- greater maturity at harvest time
- shorter, stronger stalks with less lodging
- silage with higher percentage of grain
- lower grain drying costs.

Frost damage to early seeded corn does not necessarily mean loss of the crop or the need to replant immediately. The growing point of a corn plant remains protected below the soil surface for 3 to 4 weeks after planting. Although frost may kill the first 1 to 5 leaves, usually new leaves continue to emerge from the protected growing tip with little overall final yield reduction. IF NO NEW LEAVES EMERGE WITHIN 3 TO 4 DAYS AFTER FROST, DAMAGE IS SEVERE AND REPLANTING IS NECESSARY. Replant using the earliest maturing hybrid available.

Seeding Rate and Depth Placement

A uniform plant stand is essential for successful corn production, therefore, the planting machinery must be properly maintained, correctly adjusted, and operated with care and precision. A final stand of 50,000 - 64,000 plants/hectare, for grain and silage corn respectively, is suitable for optimum corn production in the Maritime Provinces. To allow for germination losses and insect injury to seedlings, plant 15% more seeds than the intended final population. For extremely early seedings, a 25% overplanting may be

warranted. The required plant populations can be obtained by various combinations of kernel spacing and row width.

Corn seed is graded into small, medium, and large size in flat or round types. Most corn seed is now sold on a unit rather than a weight basis. One corn seed unit equals 80,000 seeds.

Too deep a seed placement often occurs in corn fields, particularly those which have fluffy, over-tilled seedbeds. Deep planted corn emerges slower and has poor seedling development, which ultimately, affects yields.

Corn Planter Operation

Regardless of the type of planter, it is of great importance to check and adjust its performance ahead of time, so that corn planting can proceed with confidence as soon as soil and climatic conditions permit. Calibration can be divided into a number of steps.

1. Make Sure that the Planter is in Good Condition

   Check all moving parts on the planter for wear, breakage, loose-fitting sprockets and gears, etc. Tighten any loose nuts and bolts. In the case of a plate-type planter, make sure that the cutoff and knockout pawls are not worn, are moving freely and have adequate springs. Hopper bottom plates should be checked, and replaced if worn.

   Where a finger-type plateless planter is used, all parts should be checked over as above. Fingers should be checked for freedom of movement and thoroughly cleaned. Fingers should not be oiled. A dry lubricant such as graphite is added to the seed for lubrication of the finger mechanism.

   If a drum-type air-planter is used, a further check is needed to ensure that the hopper, metering drum and seed tubes are airtight, and that all seals and gaskets are in good condition. Cutoff wheels should turn freely; they and the brush should be free from damage. Check fan bearings and drive belts for wear.

   With a unit-type air or vacuum-planter, fans, hoses and electrical connections should be checked for leaks, wear and dirt. Fans should be run and operating pressure checked.

2. Seed-Plate Selection

   Most older corn planters use circular rotating plates which are available in 16, 20 or 24 cells, with various cell sizes and shapes. Seed and seed plates must be matched for accurate planting. Consult the table of suggested plates printed on the hybrid bag or tag, and then check the seed for fit in the plates. The seed should be loose enough in the cell to avoid damage, but with room for only one seed per cell. With the plates in place and the planter in raised position, rotate the drive wheel and collect several dozen kernels. Check seed for damage before making a final plate selection.

   Most new corn planters are plateless and are capable of planting all seed sizes even if they are mixed together. This offers an advantage in speed and planting accuracy.

3. Adjust to Required Planting Rate

   Corn planters with or without plates have settings to plant at different rates. Read the operators manual and make the suggested setting, then drive the planter with the openers up, but with some tension on the drive wheels to check the number, spacing and condition of seeds dropped by each planter unit.

   Corn planters operate most accurately when driven slowly, however, by using 24 rather than 16 cell plates, round rather than flat seed and larger cell seed plates, it is possible to plant at higher speeds. The plateless planters are designed to operate at faster speeds than are the plate models.

4. Calibrate in Farmyard or Laneway

   Planting accuracy may be affected by planting speed and other field factors. For this reason, a calibration run should be carried out at full planting speed, over an area where the kernels can easily be found and counted. A laneway or gravel area is very suitable for this. The seed treatment that is to be used in actual planting should also be used for this calibration run.

   Refer to the table below to check the proper seed spacing for the particular population desired.

Figure 18 — Seed Spacing Required For Specified Populations

No. of plants /ha*	Seeds required /ha*	Distance between seeds (cm) at various Row Widths 76 cm (30")	91 cm (36")
45,000	52,000	25	21
50,000	58,000	22	19
55,000	64,000	21	17
60,000	69,000	19	16

*Allows for 15% non-germination. Use higher rates for very early planting. (Plants per ha × 0.4 = plants per acre; cm × 0.4 = inches.)

When purchasing corn seed, refer to the germination rates reported from the Atlantic Regional Hybrid Evaluation Trials as a guide for how much extra seed to buy and plant. Based on the local emergence data (Bulletins 100A and 140); one should overplant sufficient seed to offset the expected germination loss. For some hybrids this could amount to 15 to 20% or more extra seed. To prevent excessive germination losses, do not plant corn more than 3-4 cm deep.

Seed Treatments

Between seed germination and seedling establishment, the corn plant often requires chemical protection. Seed maggots, seed rots, and seedling blights can be caused by fungi on seed or in the soil.

Farmers are urged to thoroughly mix a fungicide-insecticide treatment with seed in the hopper at planting time, if seed has not been pretreated.

For effective planter box treatment, chemicals can be thoroughly mixed with seed as follows:

- Half fill the planter box with seed
- Add half the amount of chemical required for entire planter box (wear mask)
- Stir thoroughly with a stick (not with bare hands)
- Fill the planter box with seed
- Add the remaining half of chemical
- Stir again thoroughly.

See Publication 100A, Field Crop Guide to Variety, and Pesticide Selection for latest treatment compounds.

Corn Nutrient Requirements

Corn is a highly productive crop when properly managed, however, serious yield reductions occur when plant nutrients are not in sufficient supply. Over-fertilization is costly, inefficient and can have serious environmental consequences. Excess nitrogen can be leached into ground water if more is applied than the crop can absorb. Phosphorus contaminated run off water and eroded soil can cause eutrophication of surface water bodies. In order to ensure that both an adequate supply of nutrients is applied to optimize yield and over-fertilization does not occur, a soil test must be taken. THE ONLY RELIABLE MEANS OF DETERMINING THE NUTRIENTS AVAILABLE IN THE SOIL IS BY SOIL TESTING. A well managed corn crop can remove large quantities of nutrients from the soil as shown in the following table.

Figure 19 — Crop Nutrients Removed by Corn Yielding 12.3 tonnes dry matter/ha

Element	Amount Removed kg/ha
Nitrogen	112
Phosphorus	56
Potassium	151
Calcium	12
Magnesium	21

In addition to the above nutrients, sulfur plus seven micronutrients are also required for proper corn growth, although the micronutrients are required in smaller quantities. The soil itself has the ability to supply a significant portion of the crop's nutrient requirements by the biological breakdown of organic matter.

The amount of fertilizer required for corn is influenced by a number of factors such as: the soil's ability to supply nutrients, the previous crop and fertility program, whether manure has been added or will be added, the type of manure, its nutrient content, the soil type and its drainage characteristics, the soil pH, climatic conditions, planting date, and corn population. From soil tests, previous cropping information, and manure analysis, etc. specific fertilizer recommendations can be made accounting for nutrients from all sources.

Lime

Soils in the Atlantic Provinces are naturally acidic and, therefore, the application of limestone to correct the pH is necessary for optimal corn production. The pH range for corn is 5.5 to 6.5 with levels above 6.0 definitely preferred. On acid soils with a pH below 5.5, important crop nutrients are chemically tied up in the soil and unavailable to the plant and, therefore, crop growth can be restricted. In addition to this, toxic levels of aluminum and manganese may further restrict growth at low pH's. The optimal pH for crop growing is also the optimal pH for many soil microorganisms which are responsible for the release of many important crop nutrients from the soil organic matter.

Either calcitic or dolomitic limestone should be applied according to soil test recommendations. Use dolomitic limestone, which supplies magnesium as well as calcium, if the soil magnesium levels are low. THE ONLY RELIABLE MEANS FOR DETERMINING THE TYPE AND AMOUNT OF LIMESTONE TO APPLY IS BY A SOIL TEST. For more details on the recommended liming practices in the Atlantic region, refer to Publication No. 534-84, Atlantic Soils Need Lime.

Nitrogen

Nitrogen is essential for proper growth and development of corn. A lack of nitrogen causes browning of the lower leaves, yellowing and stunting of the plant, reductions in yield and a lowering of the plant's protein content. Excessive amounts can increase lodging and contaminate ground water with nitrates.

Silage crops harvested in the Maritimes remove from 110 to 180 kg N/ha. A number of experiments over recent years suggest that 90 to 160 kg N/ha will produce good silage yields in most situations where no manure is applied or legumes plowed down. Application rates above this are normally unprofitable. Growing dry grain corn or high moisture ear corn repeatedly on the same field may require less nitrogen, since some would be returned in the corn stalks each year.

Under dry conditions or on light soils, early growth may be retarded if urea or urea mixed with diammonium phosphate is banded at high rates (greater than 25 kg N/ha) near the seed. No more than 50 kg N/ha should be banded if ammonium nitrate is used as the source of nitrogen. When higher rates are required the nitrogen should be broadcast and incorporated prior to planting, or sidedressed/topdressed. To prevent fertilizer burn, topdress only when plants are thoroughly dry. Ammonium nitrate is normally well suited to topdress and sidedress applications since it is less susceptible than urea to volatilization losses, whereas urea can be used as a preplant application when incorporated.

Applications of manure can be an excellent source of nitrogen especially when minimal bedding is used and when stored and handled properly. Applications of cattle manure can generally supply about 50 kg N/ha to the growing crop for each 20 t/ha applied, provided it is spring applied and incorporated. The detailed value of manure for use in corn is discussed in a later section.

Legumes plowed down can also supply considerable amounts of nitrogen. Corn is a crop which is well adapted to the utilization of this source of nitrogen since the period of highest nitrogen demand corresponds closely to the period of rapid mineralization of the organic nitrogen. Specifically, the demand for nitrogen is highest during the period of rapid elongation of the corn crop, and normally soil temperature and moisture conditions are conducive to soil nitrogen mineralization during this period. Figure 20 shows the nitrogen credits that should be made to corn following forage legumes. Protein seed crops such as soybeans do not supply as much fertility to the following crop, since much of the nitrogen is removed as protein in the seed.

Figure 20 — Nitrogen Adjustments for Legume Sod

Amount of Legume	Adjustment in Nitrogen Rate kg/ha
50% or more legume	110
33% to 50% legume	55
less than 33% legume	0
legume plowdown*	45

*Applies where a thick stand of legume, over 40 cm high is plowed down in the same year it is seeded.

Source: Ontario Ministry of Agriculture & Food: Nitrogen Recommendations for Corn (Factsheet # 88-112)

If an excess amount of rain occurs after planting, some of the applied nitrogen may be lost through leaching before the crop has chance to use it. A sidedress, or topdress, of 20 to 30 kg/ha of N may be required in such cases.

Phosphorus

Phosphorus is especially important for early growth and early maturity. It is essential to band some phosphorus at planting so it is readily available to young plants with their

limited root systems. As the plant develops and the root system expands, most of the total required phosphorus is taken up by new roots growing throughout the soil. A high level of phosphorus throughout the plow layer is necessary at later stages of growth. On soils with high levels of phosphorus all of the required fertilizer phosphorus can be banded. Where soils are low in this nutrient, a portion of the required phosphorus should be broadcast and plowed down or disced in before planting. Manures are usually low in phosphorus and do not provide much benefit for early growth.

Insufficient phosphorus results in slow growth and small plants. Phosphorus-deficient plants may appear dark green with reddish-purple leaf margins and tips. Cold, wet soils can temporarily restrict phosphorus uptake by the plant even though the soil contains adequate phosphorus. Fixation by the soil of some of the phosphorus applied as fertilizer in chemical forms not readily available to the plants mean that rates of application must exceed crop removal rates. However, as soil phosphorus levels build up, more and more of the "fixed" phosphorus becomes available to plants. Thus, high testing soils require only a small amount of phosphorus banded at planting. When phosphorus is banded with a small amount of nitrogen, the plant will make more efficient use of the phosphorus. Soil pH is also very important to phosphorus availability. Phosphorus becomes relatively less available as soil pH deviates from 6.5. Application rates of phosphorus may vary from 25 to 170 kg/ha depending on the soil test level of the field.

Potassium:

CORN HARVESTED AS SILAGE REMOVES LARGE QUANTITIES OF POTASSIUM FROM THE SOIL since corn stalks are high in this nutrient. Potassium is equally available to the plant whether broadcast or banded, however, no more than 55 kg of K_2O/ha should be banded to avoid fertilizer burning and subsequently poor corn emergence. Insufficient potassium results in browning of lower leaf edges, lower yields, poorly filled ears, and increased susceptibility to stalk rot and lodging. Usually when deficiency symptoms occur, it is too late to correct the problem in the present year's crop.

Removal rates vary from 130 to 280 kg of K_2O/ha. Maritime soils contain potassium in mineral form which is slowly made available to plants. If corn is grown continuously, plant-available soil potassium may decline rapidly. Only soil testing can determine how rapidly this is occurring. If soil test potassium is declining or is already low, fertilizer additions should be increased until a reasonably constant soil test potassium level is being maintained. Generally, applications of 56 to 168 kg of K_2O/ha are adequate for good yields. Lower rates will be sufficient on grain corn fields where the stalks are plowed in. Much, or all of the potassium requirement can be met by manure applications.

Maintaining or improving the soil test level of potassium can improve yields by improving efficiency of nitrogen use.

Magnesium:

A magnesium fertilizer is only required on soils testing very low in available magnesium (Mg). The most economic source of magnesium is dolomitic limestone which will both raise the soil pH and supply the required magnesium. If dolomitic limestone is not to be applied, and magnesium is required, a soluble magnesium source can be added in the fertilizer. For further information see ATLANTIC SOILS NEED LIME, Publication 534.

Micronutrients:

Micronutrient deficiencies in corn are common, since most soils are able to supply the small quantities needed for proper growth. However, crops should be monitored for unusual symptoms. The application of manures on corn land will normally provide sufficient micronutrients. Additional micronutrients should not be applied unless soil and plant tissue analysis, as well as visual symptoms, have confirmed that a deficiency exists. Applications based on speculation are unwise and are potentially toxic to the plant. See your local Soil & Crops Specialist if you suspect a problem.

For a detailed description of fertility deficiency symptoms see publication No. 535-81, SOIL FERTILITY GUIDE.

Plant Analysis

Plant analysis can be a useful method for diagnosing a suspected nutrient deficiency. The mid-third portion of the ear leaf at the time of silking is the proper tissue used for analysis. Difficulties in interpretation of the results arises when samples are not taken at the proper stage. Samples should be taken from at least 20 plants in the sample area. A soil sample should be taken at the same time in the same area. Figure 21 shows the normal maximum and critical concentrations for corn.

Figure 21 — Interpretation of Plant Analysis Results

Analysis for Corn*

Nutrient	Units	Critical Concentration**	Max. Normal Concentration***
Nitrogen (N)	%	2.5	3.5
Phosphorus (P)	%	0.15	0.50
Potassium (K)	%	1.2	2.5
Calcium (Ca)	%	—	1.5
Magnesium (Mg)	%	0.10	0.60
Sulphur (S)	%	0.14	—
Boron (B)	ppm	2.0	25.0
Copper (Cu)	ppm	2.0	20.0
Manganese (Mn)	ppm	15.0	150.0
Zinc (Zn)	ppm	14.0	70.0

*Values apply to the mid-third of the ear leaf sampled at silking.

**Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.

***Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.

Source: Ontario Ministry of Agriculture & Food Publication 296

Manure as Fertilizer

Manure applications are highly recommended on corn fields. Besides supplying plant nutrients, it helps improve soil organic matter levels, especially when it contains significant amounts of bedding. The added organic matter helps to retain water and fertilizer nutrients, to maintain soil structure and to reduce erosion. Manure benefits coarse textured sandy soils by increasing water holding capacity and fine textured clay type soils by promoting stable structured units. Manure is especially advantageous on fields where corn is grown repeatedly.

The use of manure on corn can realize substantial savings in fertilizer costs, especially when the cost of disposing of the manure in other ways is considered. It is best utilized on fields which can use the phosphorus and potassium as well as the nitrogen. Time of application is very important. Since manure must fully decompose to release all of its nutrients only about one-half of the total nutrient content of the applied manure is available during the first year. If manure is applied in the fall or winter, a further 50% of the

nitrogen is lost to crop. Spring applied and incorporated manure supplies the most nutrients for crop use. Phosphorus in spring applied manure is of little benefit for early growth, so fertilizer phosphorus should always be banded at seeding. Liquid manure can also be injected directly into the soil as a sidedress application after the corn has emerged if the proper equipment is used.

Current values for various manures are found in the Appendix. By applying manure, commercial fertilizer applications can be reduced and production costs lowered accordingly.

General Fertilizer Recommendations for Corn Crops

In the absence of a soil test , the following "general recommendations" will provide adequate nutrients for the corn crop. However, on soils with good fertility, a savings in cost could be made following a soil test recommendation.

Recommended Practice	kg of Nutrients N	P_2O_5	K_2O	Example Rate** Analysis	kg/ha*
apply manure (spring applied and incorporated)	20-40 t solid manure or 50-100 m^3 of liquid manure				
Incorporate prior to planting	35-50	35-50	35-50	17-17-17	200-300
Band at*** planting	18-36	46-92	0	18-46-0	100-200*

*Nitrogen applications may be reduced by 50 kg/ha for each additional 20 tonnes of cattle manure spring applied, or 50-100 kg N/ha if plowing down a good legume sod (see nitrogen section). P_2O_5rates can be reduced by 20 kg/ha and K_2O by 80 kg/ha for every 20 tonne/ha of cattle manure applied (see section on manure). **Higher rate listed is for fields which have not been regularly limed, manured or fertilized.

*** Fertilizer should banded 5 cm to the side and 5 cm below seed depth. Plant injury may result from banding rates greater than 50 kg N/ha (Ammonium Nitrate), 100 kg P_2O_5 or 60 kg K_2O/ha. The risk of injury is greatest on dry, sandy soils. The urea form of nitrogen should not be banded at rates in excess of 25 kg N/ha.

The only accurate way of knowing what fertilizer is needed is by soil testing.

Fertilizer Placement

Broadcast applications — All broadcast preplant applications of fertilizer should be worked into the seedbed. Discing or harrowing usually mixes only the top part of the soil which may later dry out preventing roots from feeding in this zone. Phosphorus and potassium may be broadcast in the fall and plowed under without serious loss. Fall application of nitrogen is not recommended as losses will be significant. Broadcast applications of up to 70 kg of actual nitrogen/ha may be made after the crop has emerged 25-30 cm Some leaf burning may occur but is usually not serious if the nitrogen is applied when the leaves are dry. Nitrogen moves quickly into the soil with the first rain. Broadcast applications containing phosphorus must be worked into the soil since this nutrient is very immobile. Potassium can be broadcast on the surface on soils testing high in this nutrient, however, on lower fertile soils it should be incorporated into the plow layer.

Banding — On high fertility soils much or all of the fertilizer required for corn can be applied at planting time and SHOULD BE BANDED 5 CM TO THE SIDE AND 5 CM BELOW SEED DEPTH.

Banding phosphorus usually aids the early growth of corn, especially on acid soils, and applying nitrogen with phosphorus in the band increases the uptake of phosphorus. Plant injury may result from banded rates greater than 50 kg of N/ha, 100 kg of phosphorus/ha, and 60 kg of potassium/ha. On light, sandy, or droughty soils, or under dry conditions, the urea form of nitrogen should not be used at banded rates in excess of 25 kg N/ha. This same restriction applies to fertilizers containing a mixture of urea and diammonium phosphate. Urea, which is becoming a very common source of fertilizer nitrogen, presents no problems as long as the above banding precautions are observed.

Sidedressing — Sidedressing of corn is not a common practice among corn growers in the Atlantic Region. It is better to apply $P_2O_5$and K_2O by broadcasting before planting or by banding than by sidedressing unless a deficiency problem is being corrected. The use of liquid or gaseous nitrogen sources is still limited in the region and dry fertilizer is more easily handled by broadcasting. Little advantage has been found to sidedressing nitrogen, unless excessive rains after planting have caused large losses of nitrogen through leaching. Although nitrogen can be applied on the surface and will move into the soil, phosphorus and potassium, if applied after emergence, must be knifed into the soil. Sidedress applications of fertilizer must not be placed too close to the plants as severe root damage may occur unless placed half way between the rows at a depth of 3 to 5 cm. By the time the corn is knee-high, its roots have reached into the center of the row. Sidedressing is only possible prior to this knee-high growth stage. Do not sidedress at rates above those recommended for banding at planting (see below).

FERTILIZER IS COSTLY AND SHOULD NOT BE WASTED. FERTILIZER APPLICATIONS BASED ON SOIL TESTS ARE MORE EFFICIENT AND RETURN MORE PROFIT.

Weed Control

Recognition of new weeds, either to the area, the farm or individual fields, is an important step in preventing new weed infestations. The best control of many new weeds is by pulling or hoeing small infestations that are new to the farm or field and thereby preventing its spread. The movement of weed seeds via transport of feeds and seed is a very real method of new infestations, whereas locally, machinery (e.g. harvesters) and manure spreading often are the methods responsible for weed seed movement. Unfortunately, preventative measures are often impossible and, therefore, both cultural and chemical weed control methods are available to corn growers. Good cultural control starts with a proper plowing job. Deep rooted perennial weeds should be cut off and completely buried by the plow. Grasses should be well covered. Harrowing in the spring will destroy many germinating annual weeds. An aggressive corn crop, planted at the optimum time with good fertility at the recommended population will give weeds some measure of competition. Cultivation once the crop has emerged will control weeds between the rows but not within the row. Several passes with the cultivator may be necessary to keep the weeds down. Once the crop is 50 cm tall, roots extend well into the row and will be damaged by further cultivation.

With the number of herbicides and methods of application recommended for corn, excellent weed control can be achieved if the herbicide spray program is planned in advance. To plan successfully keep the following points in mind:

1. A KNOWLEDGE OF THE SPECIFIC WEEDS PRESENT IN EACH FIELD allows the selection of the best treatment for these fields. Keep a record of these weeds, and be prepared to change treatments if one or more particular weeds start to build up. Watch for triazine-resistant weeds.
2. ALWAYS LEAVE YOURSELF A SECOND CHANCE. If you go with a preplant incorporated (ppi) or a preemergence (pre) treatment, you can still apply a postemergence (post) treatment lightly if necessary. If you ignore the possibility of ppi or pre treatments and apply only a post emergence herbicide then you have no other options if that treatment fails to give satisfactory weed control. Growers should be aware, however, that ppi and pre treatments are slightly prone to either leaching or runoff, respectively.
3. OBTAIN THE CURRENT GUIDE TO WEED CONTROL, Publication 75, early so you have time to read detailed instructions. Please refer to Publication 100 A, Field Crop Guide to Variety, under Pesticide Selection. Order your herbicides early.
4. UNDERSTAND THE RESIDUAL POTENTIAL OF ATRAZINE so that this does not restrict your cropping options. Field crops following corn in the rotation (e.g. alfalfa, timothy, barley, etc.) are quite susceptible to moderate levels of residual atrazine.

When significant quackgrass populations are present, then growers must weigh the non-restrictive and longer control attributes of glyphosate versus the lower cost of atrazine. Glyphosate is extremely effective on quackgrass when applied properly, prior to fall tillage or in early spring providing there is 3-4 actively growing leaves per plant.

If atrazine is used instead, then best results normally occur when a split application is used. The first half should be applied as a preemergent treatment with the remaining half applied at the 6-leaf stage.

It is extremely important when handling herbicides to take every necessary precaution to avoid spills, excessive application, leaky booms, backsiphoning, overloading sprayers, etc. to help avoid water contamination. Controlling soil erosion helps in preventing herbicide contaminated soil from moving into aquatic systems. READ THE LABEL and follow directions when storing, handling herbicides and always avoid skin and eye contact, inhalation of vapours, etc.

Corn Insects

Seed-Corn Maggots and Wireworms

Most commercial corn seed is already treated with a fungicide, and possibly with an insecticide to control storage insects. This treatment does not control seed maggots and wireworms in the field, so corn seed should be treated with proper insecticides just prior to planting. Prepared packets containing the correct amounts of these insecticides for treating a bag of seed are available commercially.

Wireworms are often numerous in land that has been in sod several years, particularly wet, heavy soils. Crop rotation is recommended for wireworm control. If not practical, chemical controls may be used.

Armyworm

Armyworms are attracted occasionally to weedy and grassy corn for egg laying. If armyworm larvae move into corn fields, spray the border row and adjacent areas. Normally, armyworm infestations are limited to localized areas and they rarely cause any economic damage to field corn.

Potato Stem Borer

This occasional pest of weedy corn fields bores into plants at ground level early in the season. It has one generation and is sometimes confused with the later appearing European corn borer. It is a pest of grassy fields and difficult to control with insecticides. Maintain weed-free fields, borders, and fence rows by plowing, cultivation, and with the use of herbicides.

Corn Ear Worm

This insect migrates from the south preferring to deposit eggs singularly on corn silks from mid-July through September. These eggs hatch in 7-10 days and the larvae burrow through the silk into the tips of ears. The corn ear worm is normally a tip feeder and cannibalistic. Principal damage is due to the opening of ear tips to fungal infection and bird feeding. Control can be obtained with several repetitive insecticide applications. The use of pheromone traps is recommended for monitoring adult activity when fresh silks are present.

Fall Armyworm

This southern migrant deposits eggs in bunches anywhere on the exposed corn plant from mid-July through October, but is most prevalent in September. On small plants the larvae feed in the whorl and leaves. Later in the season the larvae attack tassels, silks and ears. Highly cannibalistic, they consume corn borers in the stalks, and are usually found at either end of the ear. Control is difficult but the foliage can be sprayed in early season to save the whorls and leaves in severe infestations. Additional application may be needed for ear protection. Pheromone attractant traps for monitoring adult activity will help time chemical applications.

European Corn Borer

This insect is the major cause of stalk breakage in the Atlantic Provinces. The adult moths emerge in late June through early July producing one generation a year. Yield loss in silage corn is seldom high enough to warrant chemical control. However, if grain corn is grown repeatedly in the same field, large populations will develop. Newly emerging tassels should be examined in mid to late July for borers or feeding injury and if more than 75% of the plants are infested, insecticide should be applied. A light infestation does not justify spraying. Control is effective only if the borers are destroyed before they enter the stalk. One properly timed application before young larvae descend the stalks is sufficient. Pheromone traps can be used for monitoring adult activity. It is most important to select a hybrid with good stalk strength. In addition, farmers should plant as early as feasible to obtain as early a harvest as possible. Harvest as soon as suitable moisture levels are reached to reduce losses from dropped ears and broken stalks which occur during autumn storms. Crop rotation is an effective method in reducing population buildings.

Miscellaneous Insects

Corn leaf aphids are generally present and abundant in many fields in late August. Populations of two predators, the transverse ladybeetle and the newly introduced seven-spotted ladybeetle increase rapidly when aphids are present and prevent appreciable corn injury.

Two-spotted mites may also become numerous in some years after long dry spells. These insects produce webbing on the underside of the leaves, leaf curling and stippling. Moist weather conditions, predacious mites and insects generally keep the mites controlled.

Sap beetles, a 5-6 mm reddish brown insect with 2 pale yellow spots on each side of the back, feed on decaying plant materials, sap oozing from plants, and fungi. In corn they may enter the injured ear tips and corn borer holes, but they are not themselves injurious.

For specific pest control chemicals, refer to Publication 100A, Field Crop Guide to Variety and Pesticide Selection.

Bird And Raccoon Damage

Birds may cause considerable damage to corn fields, especially to grain corn. Damage occurs during emergence when the seedlings are pulled out of the ground and also during grain filling and ripening when bird such as blackbirds, starlings, cowbirds, and crows feed on the grain. The ears are damaged either by direct feeding or by ear rot resulting from the invasion of secondary organisms once the husks have been loosened. Random, irregular shooting of pest birds may be advantageous. The cadavers should be left in the field.

Raccoons can be difficult pests to control and can cause significant damage in localized areas. One strand of electrified wire placed approximately 10 cm above the ground around the perimeter of the field will normally deter raccoons from entering a field. The fence must be placed in a weed-free area and should not be further than 60-90 cm from the outside corn row.

Diseases

Corn grown in Maritime Canada suffers from few destructive diseases. However, some are present, and given favourable conditions can cause damage to corn crops.

Eyespot — One of the most common diseases of corn, eyespot, is a fungus disease which attacks the leaves and stems of corn. It creates round or oval-shaped, white lesions which can, in severe cases, cover much of the plant giving it a frosted look from a distance. Eyespot is most severe in wet seasons and in fields with the corn debris from the previous season's crop still on the surface. Some hybrids are particularly susceptible to eyespot. Crop rotation and clean plowing of corn debris help to reduce disease severity.

Ear rot — Ear rot shows its presence in the form of pink, white, green or black moulds which develop on ears. The pink and white moulds may produce toxins which can have serious effects on livestock, especially pigs and poultry. The development of the mould is topped when the corn is dried or ensiled, but the toxin content, if present, is unchanged. Corn stored in cribs may also develop the fungus under favourable weather conditions until the corn moisture drops below 20%.

Ear rot is particularly bad under wet conditions when harvest of corn is delayed beyond the normal time. Where birds and insects have damaged the corn by opening the cob to the weather, the disease severity may be higher.

There are a number of general preventative measures to help minimize corn disease:

1. Plant hybrids resistant to eyespot.
2. Plow under old corn stalks and leaves to help kill overwintering disease fungi.
3. Rotate corn with other crops to prevent disease build-up.
4. Minimize plant stress by — (a) avoiding plant populations that are too high for the hybrid grown; (b) maintain high soil fertility, good soil structure and good drainage.

Harvesting Corn For Silage

The object of silage production is to produce plants with high proportion of well developed ears on which most of the kernels have reached the hard-dough stage or physiological maturity before fall frost. Physiological maturity is reached when a black layer has formed at the base of the kernels. At this stage of maturity, grain filling has ceased, whole plant dry matter is approximately 30 to 35%, which is ideal, and the silage will be most acceptable to livestock. Improvement in both the silage's palatability and feed value are responsible for improvements in intake (see Figure 22). Furthermore, animals can consume a smaller volume of a well matured silage and obtain the same amount of nutrients that would be contained in a wetter silage. If the corn silage is too wet, animals may not be able to consume enough bulk to meet their needs.

Figure 22 — Effect of Maturity on Dry Matter Intake, Protein Content, and Energy Content of Whole Plant Corn Silage (Unfrosted)

Whole plant Moisture %	Energy Descriptive State	Energy Dry Matter Basis	Protein Dry Matter Basis	Intake kg DM/day
80	Milk	64.5	9.0	10.5
75	Soft Dough	67.2	8.4	11.5
70	Hard Dough	69.3	8.0	13.0
65	Mature	69.1	8.0	15.0

Source: Corn Silage — Publication 92 — Ontario Ministry of Agriculture & Food.

Intake Data — Demarquilly in Quality of Silage Maize, Digestibility and Zootechnical Performance.

Frosted corn harvested for silage after reaching the physiological maturity stage is often too dry to ensile well, resulting in a mouldy, unpalatable product.

The cutting knives and ledger plates on silage harvesting machinery must be kept sharp and adjusted to cut the corn plant and ear into pieces about 6-11 mm in length. The finer cut, needed when the crop is overmature and frosted, permits tighter packing, thereby excluding air and reducing the possibility of spoilage.

An immature silage will seep when ensiled resulting in significant deterioration of concrete silo walls and a loss in silage nutritive value. The silage juices damage the silo by eroding the concrete as they wash down the walls and by being forced hydraulically to penetrate the concrete wall or staves. These two processes weaken the silo and reduce its useful life. The silage moisture content at which seepage will occur, depends upon its height and width. The potential for seepage of silage effluent increases rapidly at moisture contents above 72%, even at greatly reduced heights.

Silage effluent is rich in nutrients and can cause significant environmental problems if not adequately contained.

Ideally, the choice of hybrids and the planting and harvest schedule should permit the corn to be harvested prior to the normally expected first killing frost in the area. If a corn crop is heavily frosted while kernels are still in the milk stage, several days of drying in the field are advisable before harvest. However, if kernels are dented before frosting, it is best to harvest immediately. As the frozen plant dries out after frost, some yield loss occurs, the nutrient content of the plant decreases, especially N, K, Ca and Mg and the feeding value is reduced.

Storing Corn Silage

The type of silo to be used should be investigated thoroughly before a corn program is initiated. The most efficient and economical setup depends on size of herd, amount of corn, type of animal housing, and other management factors. Before making any investment in silos or mechanization, it is wise to visit and study as many operations as possible. Avoid buying or building equipment which may not be readily adaptable to long range plans. Corn silage ensiles easily if it is harvested at the correct moisture, chopped to the correct length, packed well and is covered properly to exclude air. Almost any type of airtight structure can be used. See Appendix for details on silo types, capacities and details of filling.

Harvesting Grain Corn

Corn growers use a variety of methods to determine when their crop is mature. Kernel moisture is usually used to determine when to harvest. Growing degree days, or even calendar days accumulated after emergence, or after silking, have been catalogued as a means of predicting date of maturity. Kernel black layer formation at the base is an accepted indicator of physiological maturity (maximum dry weight).

The main problem associated with the use of the black layers is variability in the color and time of its appearance. Workers, especially those lacking experience, are often unable to tell just when the layer has formed.

There is another visual indicator of corn maturity that is now used somewhat. When an ear of corn is broken in half, the tip half of the ear contains kernels with their smooth or endosperm sides exposed. As the ear approaches maturity, a "line" can be seen on the smooth side of the kernels. This line is called the milk line, or the starch layer, and it marks the boundary between the solid and liquid portions of the maturing endosperm.

Research in Ohio established 40 years ago that at the "ripe" stage in corn there is no milk left in the kernel. This suggests that disappearance of kernel milk must be a useful indicator of corn kernel maturity.

In the Maritime Region, we suggest that to assess maturity adequately, slice kernels lengthwise and assess for moisture, milk line and black layer. If maturity looks good, then shell off some kernels and take to a grain center, feed testing lab, or some other place that has an electric tester that will measure kernel moisture accurately (even above 25%).

A number of options are available to farmers interested in harvesting and storing grain corn. The choice of a system must fit both the achievable maturity of the corn hybrid in the area and the requirements for an animal feed or a product for sale. The most common methods are as follows:

1. Grain combine fitted with corn head. This arrangement, rapidly gaining popularity, provides flexibility in harvest. The grain should be less than 35% moisture at harvest for optimum results. The self propelled combine, properly equipped is a well balanced, efficient machine which can operate under more extreme conditions than pull type equipment.

   Normally, only the grain portion of the corn is harvested. It may be artificially dried or stored in a silo. If the corn is to be fed to cattle or cows, the combine can be adjusted to harvest the whole cob with the grain kernels. Slight modifications to the cleaning area of the combine are necessary but the ensiled product is free of stalk, silk and trash making it a high value product for ruminants.
2. Corn pickers. A corn picker is a 1, 2 or 3 row tractor drawn machine which may either simply husk the cobs or husk and shell the corn after the cobs are picked from the stalks. Shellers may on some machines be removed if desired. Picker huskers/shellers produce a good product if the corn is properly matured and the machine is in adjustment. Cobs picked by this method may be cribbed or ground for ensiling as high moisture ear corn. If a sheller attachment is used the corn may either be dried or ensiled as high moisture shelled corn.

   On wet, muddy conditions and on sloping ground, tractor drawn picker husker/shellers are at a disadvantage compared to self propelled combines, although they are a cheaper option for farmers without access to a combine. This is especially true for farmers with smaller quantities of corn.
3. Snapper head equipped forage harvesters. Forage harvesters can be equipped with special corn heads which pick or snap the cobs from the corn plant similar to the action of a corn picker. The cobs and kernels, however, are then ground by the harvester. A 13-19 mm recutter screen is installed to ensure proper particle size of the meal before it is blown into a wagon or truck for transport to the farmers silo. The high moisture cob meal is good feed for ruminant animals. Forage harvester produced cob meal has one disadvantage from picker husker or combine type cob meal in that often the cobs are not husked properly and varying amounts of trash can travel into the chopper. This lower value material will dilute the feeding value of the cob meal. Despite the fact that this method of harvest does offer obvious advantages to farmers already equipped with silage or haylage equipment, grinding either in the field or going into the silo requires large amounts of power and slows the harvest.

Storing Grain Corn

Dry Storage

Artificial Dryers — Shelled grain corn with a moisture content above 15.5% will not store properly. A wide range of dryers and techniques are available to dry corn to that level. Most common types are the in-bin batch type dryers and continuous flow type dryers. The in-bin dryer is the most popular where small amounts of corn are to be handled due to its low initial cost. It is inherently slower and usually of smaller capacity. Some in-bin designs can be made to operate on a near continuous flow basis, but most operate on single loads like the batch dryer. Larger operations and grain elevators usually operate continuous flow type dryers which can be more fully automated and operated on a more efficient basis.

When drying corn from a high moisture to its safe storage state at 15.5%, it is desirable to allow a period of equalization during the process so that the moisture at the heart of the kernel has a chance to migrate to the outside. In a process called dryeration, this steeping of the hot kernels increases capacity of the dryer and reduces stress cracking and drying costs. DRYING OF GRAIN THAT EXCEEDS 25% IN MOISTURE IS VERY EXPENSIVE AND SHOULD NOT BE ATTEMPTED UNLESS ABSOLUTELY NECESSARY.

Wet Storage

Silos — High moisture corn can be ensiled as shelled, ground shelled, or ground ear corn. The moisture limits for ensiling either form of shelled corn are about 24 to 33% kernel moisture. For ensiling ear corn the limits are 25 to 40% moisture.

Ground ear corn will store well in any type of storage which is sealed properly to prevent air from re-entering. High moisture shelled corn and corn cob mix (i.e. combined ear corn), however, should be rolled or ground before ensiling in "open top" concrete upright silos, bunker silos or piles made on a slab. Farmers with oxygen limiting or sealed silos have the option to process this type of corn either going in or coming out of storage, prior to feeding.

With a valuable energy supplement such as high moisture grain corn, serious quality deterioration can take place with a slow feedout rate, particularly during warm weather conditions. Careful attention should be given before building a silo/ground pile, such as herd size and daily corn feeding requirements.

Figure 23 — Approximate Silo Capacities For Shelled and Ground Ear Corn*

Moisture Content &	Approximate weight of shelled corn (kg at 15.5% moisture equivalent) per 30 cm of height for various silo-diameters in meters (m)				
	3m	4m	5m	6m	7m
Shelled Corn					
15.5	1522	2705	4226	6086	8284
24.0	1409	2505	3913	5635	7670
30.0	1321	2348	3669	5283	7197
Ground ear corn					
24	885	1573	2457	3538	4816
28	845	1502	2348	3381	4602
32	813	1445	2258	3251	4425
36	795	1415	2210	3183	4333

*Source: 0.1. Berge, Dept. Ag. Eng., Univ. Wisconsin. meters × 3.3 = feet

Organic Acid Preservation — Commercially available organic acid preparations such as propionic and propionic plus acetic acid can be used to preserve high moisture shelled grain. By lowering the pH of the silage, these organic acids either kill or prevent the growth of those organisms which cause spoilage. Application of the acid requires special equipment which sprays the chemical on the corn is it is augered into storage. There are no restrictions on the type of storage used, except that the product must be protected from rain and snow. Since the acids used are corrosive to metal, proper precautions must be employed to prevent personal injury and deterioration of equipment.

An important advantage of organic acid preservation of grain is that the effectiveness persists even after the grain is removed from storage for grinding and feeding.

FOR FURTHER INFORMATION ABOUT THE GROWING, HARVESTING, AND STORAGE OF EITHER SILAGE OR GRAIN CORN, CONSULT YOUR LOCAL SOIL AND CROP SPECIALIST.

Cereal Crops

Introduction

In the 1990's cereal crop production in the Atlantic Provinces will be quite different compared to the previous decade. It is difficult to predict what further changes will take place in regional self-sufficiency, compared to the 3.5% increase for the 1986-90 period reported by the Atlantic Farmers Council, however, it is safe to predict there will be significant changes in farm management strategies.

Farmers will be taking more of a Maximum Economic Yield (MEY) approach rather than the "complete package treatment" that was utilized during the 80's when market prices were much stronger. In the MEY management approach, each fixed and variable production cost component will be weighed carefully before proceeding. Maximum economic yields will result from paying more attention to basics such as soil fertility (i.e. particularly the nutrient contributions from organic sources), seed depth placement and combine losses to mention a few. Further fine tuning of pesticide selection and timing, reduced tillage systems for optimal seedbeds, crop rotations,, nitrogen catch crops and utilization of revenue "safety nets" will be witnessed in cereal production for this region. To lessen machinery carrying costs neighboring producers will increasingly form machinery co-ops to purchase certain types of equipment such as land levellers, roller harrows and specialized combine headers or rely on custom operators for procedures such as manure spreading and injection and/or pesticide storage and application.

Cereal crop production in the region is very important to provide not only feed sources but also to provide the needed crop rotations with other crops, (i.e. forages, potatoes, vegetables). At times, net returns alone (affected by market price and/or climatic influences) may not justify production of cereal crops. However, the benefits from cereals in a sound crop rotation and the need to help reduce the greater than 50% importation of livestock feed should justify progressive cereal crop production in this region.

Soil and Crop Management

Sound soil and crop management practices are important in cereal production to maintain good soil fertility, structure, organic matter content, and minimize erosion and compaction damage. Most farmers are quite aware of the cost of soil degradation and are taking steps to conserve and enhance soil through winter cover crops, proper crop rotations, manure incorporation, and improved tillage methods. Cropping systems which leave the soil disturbed and bare of vegetation after autumn harvest, contribute greatly to soil erosion.

Tillage

In recent years, several new options in tillage equipment have been utilized in the Maritimes. Primary tillage implements such as chisel plows or off-set disc harrow, are used on corn or grain stubble to produce quicker initial tillage results than the conventional mouldboard plowing practice. The chisel plow, or off-set discs, are sometimes referred to as "conservation tillage implements". These implements can leave higher amounts of crop residue on the soil surface of sloping fields (greater than 5% slope) to minimize potential soil erosion losses. Mouldboard plowing is, however, the desired method of tillage on sod land to produce a proper seedbed under these conditions and reduce annual grass weed problems somewhat.

In terms of secondary tillage implements, farmers are relying more heavily on "S" tine harrows with rolling crumblers or roller-harrow combination units, than the traditional disc and spring tooth harrows which often left seedbeds overworked and fluffy. Disc harrows are still necessary, however, on some heavier textured soils or in fields coming out of forages. When using a disc or even spring tooth harrows, consideration should be given to limiting the number of passes and rolling *prior* to planting, if necessary. Too often, seed placement is too deep in overworked and fluffy soils.

Whatever tillage system is utilized, the seedbed produced should:

- permit early planting
- maintain or improve the soil structure
- destroy weeds germinated prior to planting
- permit uniform depth and placement of seed and fertilizer
- provide conditions for rapid seed germination

Adaptation

Cereals perform well under the cool moist growing conditions present in the Atlantic region. Hot dry weather in the latter part of the summer may hamper grain filling and be detrimental to yield and grain quality. Warm, humid weather is detrimental to high yield and quality since most leaf and head diseases become more severe when moisture remains on the plant surfaces for long periods of time. Excess soil moisture is also responsible for poor performance of cereals. Barley is the most sensitive and oats least affected by wet soil while wheat is similar to barley.

Autumn sown cereals including winter wheat, rye and triticale are more exacting in their requirements than the corresponding spring planted crops. Autumn planted cereals may be successfully grown in most years when sown under conditions of proper seeding date and suitable field selection. Winter barley is very susceptible to winter injury. No winter barley varieties are recommended at this time in the Atlantic Field Crops Guide-Publication 100A. The use of well drained soils and protection from wind are critical as winter cereals may die if subjected to ice sheeting, frost heaving, or wind damage during winter melt periods when snow cover is lost. Continuous snow cover is most advantageous for successful winter cereal production provided that the soil freezes beneath the snow to reduce the harmful effects of snow molds, a group of pathogenic fungi which thrive at temperatures just above freezing. Winter cereals have a higher yield potential than spring cereals but require more management. Winter cereals cannot be planted in the spring because they require a period of cold temperature to stimulate them to flower and produce seed.

Species Selection

The nutritional requirement of each animal enterprise will dictate the preferred feed source. The feeding value of wheat on an energy basis, is higher than barley, rye or oats. An average livestock producer must produce or purchase 3.7 tones of oats to equal the feeding value of 3.2 tonnes of barley or 3 tonnes of wheat. The feeding value of oats is lowest primarily due to the presence of the non-digestible

hull. The oat groat (kernel less hull) or hulless oats is very high in energy and protein quality. Triticale, a new crop appears to have potential in the Atlantic area. It is a cross between wheat and rye, with some of the characteristics of each species. Trial data indicates that both winter and spring triticale yield equal to, or slightly better than, the highest yielding wheat or rye varieties. The feeding value of triticale is equal to or slightly superior to barley with a lower level of fibre.

With the understanding that each species has a different feeding value, a producer must then choose the species that best suits his land capability and required end use.

All grain species do best on well drained, fertile, high pH soils. However, some species are more tolerant to conditions that are less than ideal or they can make use of higher levels of inputs. The following figures indicate some of the requirements of cereals.

Figure 24 — Drainage Requirement

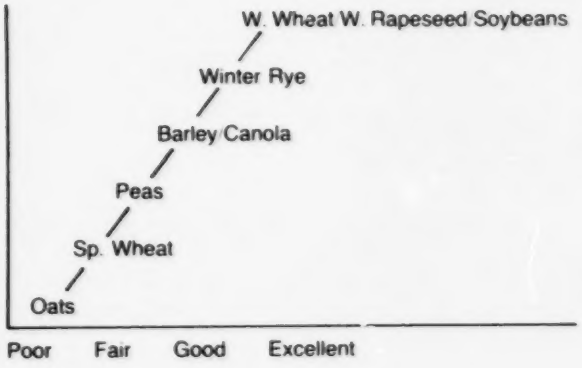


Figure 25 — pH Requirement

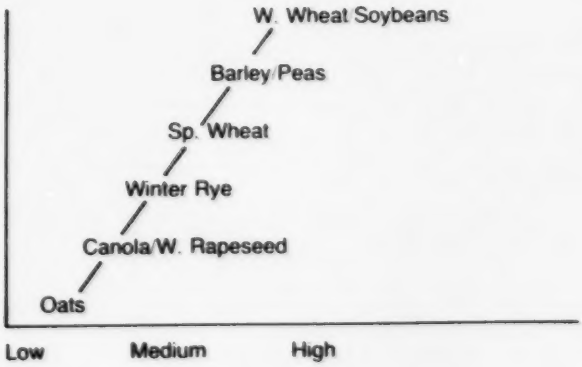


Figure 26 — P & K Requirement

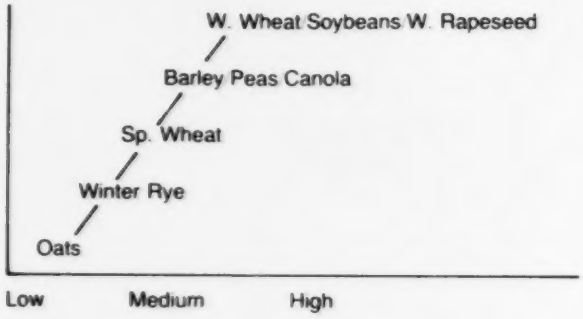
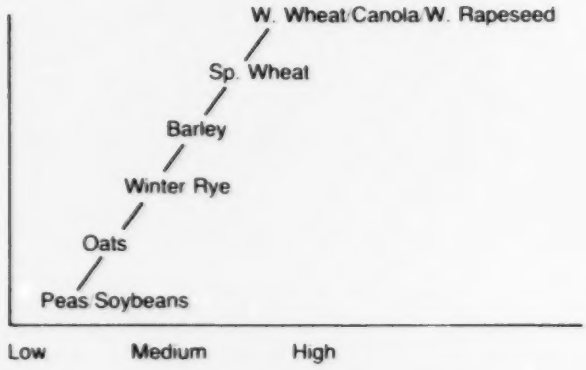


Figure 27 — Nitrogen Requirement



In general, oats can tolerate poorer growing conditions and require fewer inputs, but yield and quality are considerably less than other grains. See table page 50, "Estimated Removal of Plant Nutrients by Various Crops."

Variety Selection

Varieties differ in their inherited agronomic characteristics of days to maturity, straw strength (lodging), disease resistance, yield potential and winter hardiness. Varieties should be selected to suit individual requirements keeping in mind that some variety limitations may be overcome by appropriate crop management practices. Varieties with a high yield potential, but susceptible to lodging, may have this limitation overcome by the use of a plant growth regulator. Early spring planting of a variety susceptible to certain leaf diseases may decrease yield loss.

Specific characteristics for each variety can be found in Field Crop Guide to Variety and Pesticide Selection, Publication 100A, which is updated annually.

Seed Quality

Seed quality is extremely important to obtaining a good yield of high quality. Using pedigreed seed produced under an inspected quality control program guarantees variety purity, low weed seed content and high germination. In cereal grain, the following pedigreed seed grades exist: Breeder, Select, Foundation, Registered and Certified. The first four grades are used by seed growers to increase seed supplies. CERTIFIED SEED is the grade intended for general crop production. Certified seed can be identified by a blue tag on the bag carrying two identification numbers.

Non-pedigreed seed cannot be sold or guaranteed by variety name. If non-pedigreed seed is to be used, it should be tested for germination and cleaned to remove seeds of weeds and other crops. To check for germination, take a representative sample of the grain being sown and count out 100 seeds. Spread these on a moist paper towel, fold the towel and place between two plates. Keep the seeds moist and at room temperature for 7 - 8 days. Determine germination by counting the number of seeds which produce normal sprouts and roots. If the germination is below 75%, the seed should not be used. Some seeds may be dormant due to drying. To overcome this, chill seed in refrigerator for 3 - 4 days before testing. Dormant seeds will germinate normally in the field. Seed which germinates readily and produces rapidly growing seedlings is high in vigor. High vigor seed is an additional indication of quality.

In addition to germination, there are other criteria which characterize good seed, including: high protein content, kernels are uniform, plump clear color and freedom from disease organisms.

Seed of adequate germination and vigor should be treated with a fungicide before planting.

Seeding Rate

The seeding rate in kilograms per hectare of grains should be determined after considering a number of factors including desired plant population (may vary with tillering ability of species and variety), kernel weight, and percent germination of the seed lot being used. The desired plant population (plants/m^2) can only be accomplished if seeding rates are adjusted to accommodate seed weight. Seed lots of different seed weights will contain a different number of seeds in one kg of grain. For example, a seed lot with a seed weight of 30 g/1000 seeds will have 33,333 seeds/kg, while a seed lot of 40 g/1000 seeds will contain only 24,000 seeds/kg. If both these seed lots were planted at the same weight/ha, there would be a 33% difference in the actual seeds planted. In order to ensure that the desired amount of viable seed is being planted, the rate must also be adjusted to accommodate the specific germination percentage of the individual seed lot being used. For the non-intensive grain grower, the following rates can be used as a rough guide: oats 120 kg/ha; barley 125 kg/ha and winter and spring wheat 134 kg/ha. For the more intensive grain grower, see Figure 28, for seeding rates based on 1000 kernel weight and viable seeds/m^2.

Figure 28 — Seeding Rate of Grains (Kg/ha)

Seed Sample wt of 1000 seeds (g)	Viable Seeds/m^2 250	300	350	400	450
30	75	90	105	120	135
35	87	105	123	140	158
40	100	120	140	160	180
45	112	135	158	180	203

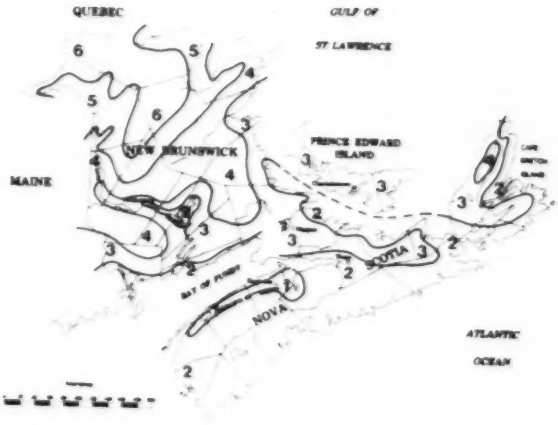
Seeding Date

Spring grains should be sown as early as the land can be prepared satisfactorily. Early seeding gives the crop more time between emergence and maturity, providing a longer growing period for plant development. Under average conditions, each week's delay in spring seeding of grain beyond the first date when soil conditions are favorable, results in approximately 10 percent reduction of total yield.

An early sown grain crop is more resistant to most disease and insect pests because it is at a more advanced stage of growth when attacked. Higher yields of well filled grain with a higher weight per unit of volume result from early seeding. Early sown spring grain matures early, escaping many hail storms and wet soil conditions during combining.

Seeding date also has an important influence on the performance of winter cereals. Seeding before the optimum seeding date produces plants with excessive top growth which are susceptible to disease and lodging. Seeding after the optimum seeding date results in plants that are not well established before freeze-up, making them more susceptible to winter injury, heaving and delaying growth the following spring. Zones of optimum planting dates have been established based on autumn temperatures in each region (see Figure 29). For best results, seed within the optimum period indicated for your area. Some variation in optimum planting period may occur within zones due to local factors, for example, sheltered southfacing slopes. Recommended dates may need some adjustments based on local experience. Differences in autumn weather between years will also cause the optimum dates to vary.

Figure 29 — Zones of Optimum Seeding Period for Winter Grains Based on Climatic Data.



ZONE DATE

1	Sept. 10-25	4	Aug. 27-Sept. 7th.
2	Sept. 5-20	5	Aug. 22-Sept. 2nd.
3	Sept. 1-15	6	Aug. 20-Aug. 27th.

Note — Production of winter grains in zones 5 and 6 is very risky. All other agronomic factors must be suitable in each zone.

Seeding Methods

Cereals are usually seeded with a grain drill, pneumatic seeder or by broadcasting. The method chosen should permit the earliest and most rapid seeding of spring cereal on existing soil conditions. Objectives are to maintain consistency of seeding rate, depth and seed coverage for uniform germination and emergence. These objectives are usually easier to achieve with drill seeding than broadcasting. However, some operators are obtaining good results with the latter method by harrowing lightly after broadcasting, to cover the seed.

Under normal conditions, cereal grain is sown approximately 1-2 cm deep. Seeding depth is a management factor that many farmers take for granted, but is far more important than most think. If cereals are sown too deeply, emergence is slowed, plants are weak and yield potential is lost. Seed

placement in the soil should be relatively shallow so the crop emerges quickly, avoiding seedling disease and saves energy to put into growing early leaves rather than using energy to push up through 4-8 cm of soil. The only danger in seeding too shallow is lack of moisture, however, it is not usually a problem with early seeded crops in the Maritimes. Methods to ensure proper seeding depth are level seed bed prior to planting, depth bands on the seeder, and possibly rolling prior to planting. Depending on soil texture and moisture, rolling immediately after seeding may be helpful to pack loose, dry soil more firmly around the seed to improve uptake of moisture. Avoid packing or rolling land which is damp, as it may crust. Rolling these areas after the grain has emerged is a safer practice.

Flotation Spring Seeding

Flotation seeding can be used to plant spring cereals on lands that normally remain wet in the spring until well beyond the optimum planting data. Tractors equipped with flotation tires are needed to plant soon after ground frost has come out. The best time is when the top few centimeters of soil begins to dry, but the main portion of the plowed area may be very close to field water capacity. Fields to be seeded in this method should be fall plowed with special care to ensure a smooth soil surface, since spring tillage will be very minimal.

Several approaches have been used to facilitate the planting process, but the most commonly used method is to broadcast the fertilizer, harrow the field with a light cultivator to a shallow depth (5-10 cm), broadcast the seed and then cover with a chain harrow. In some cases the fertilizer and seed are applied and then incorporated by harrowing.

This practice should only be followed when adequate flotation equipment is available to avoid soil compaction and when the fields are sufficiently damp that conventional seeding will be delayed beyond an acceptable date.

Tramlines

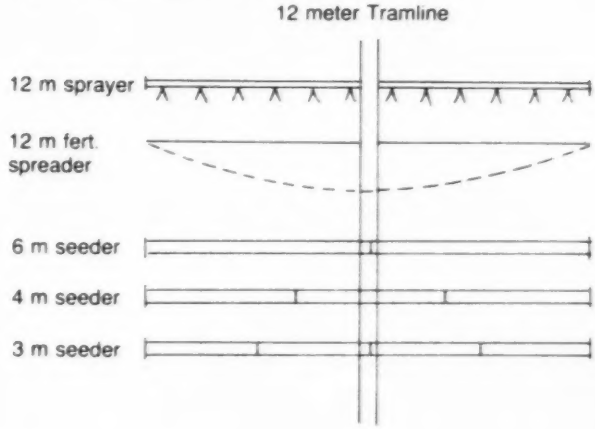
Tramlines are unseeded parallel rows established at planting time in cereals to accommodate the wheels of equipment used for precise applications of fertilizers, plant growth regulators and pesticides. These missing rows do not contribute to lower yields and they avoid the late maturing low quality harvest caused by grain damaged by tires of application equipment. This distance between the unseeded rows of a tramline set must correspond to the tire spacing of equipment to be used for the application of additional management inputs.

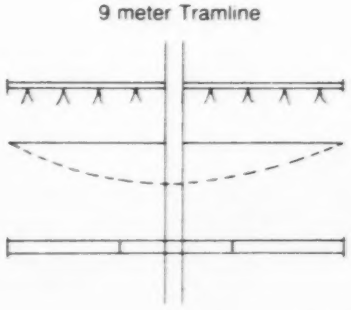
The distance between sets of tramlines is usually a multiple of the seeder width and must match the effective application distance of both sprayer and fertilizer applicator. A popular tramline spacing is 12 m, which can be accomplished by using either a 6m, 4m or 3m wide seeder (figure 30). Producers with narrower spray booms and fertilizer applicators may wish to use a tramline system with a 9m wide spacing.

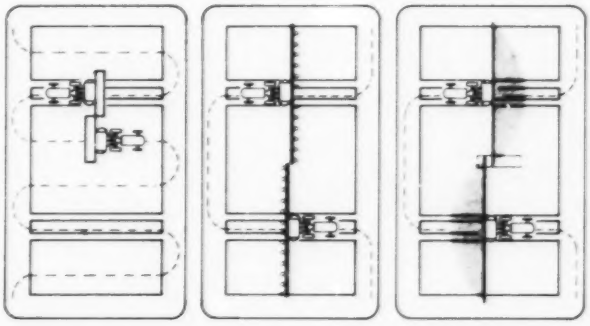
The pneumatic type air seeders are well suited for making tramlines as the delivery tubes can be closed off at the distributor head. Conventional type seeders have been successfully modified to establish tramlines by mechanically opening and closing drill spouts, using a lever from the tractor seat or a remote hydraulic cylinder.

In establishing a tramline system, two complete sets of tramlines should be made around the outside of the field. This allows adequate room to use the inside tramline to turn at the end of the field without concern that a slightly wide turn may result in a sprayer boom contacting an obstruction on the edge of the field. After the two outside tramlines have been established, seeding should start on the straightest, longest side of the field and progress across the full width of the field. Where a field has no obvious straight side, a pass can be made the length of the field to establish a reference point. Seeding is then done on either side of this initial pass until the field is completed.

Figure 30 — Tramlines







A simple method for forming tramlines is to close the two drill coulters which match the wheel spacing of equipment (left). These tramlines can be used later for entering the crop to apply fungicides (centre) and fertilizers (right).

The tractor used for spraying and fertilizing should have the narrowest tires possible to lessen the required width of the unseeded tramline and reduce excessive damage along the edge of the tramline.

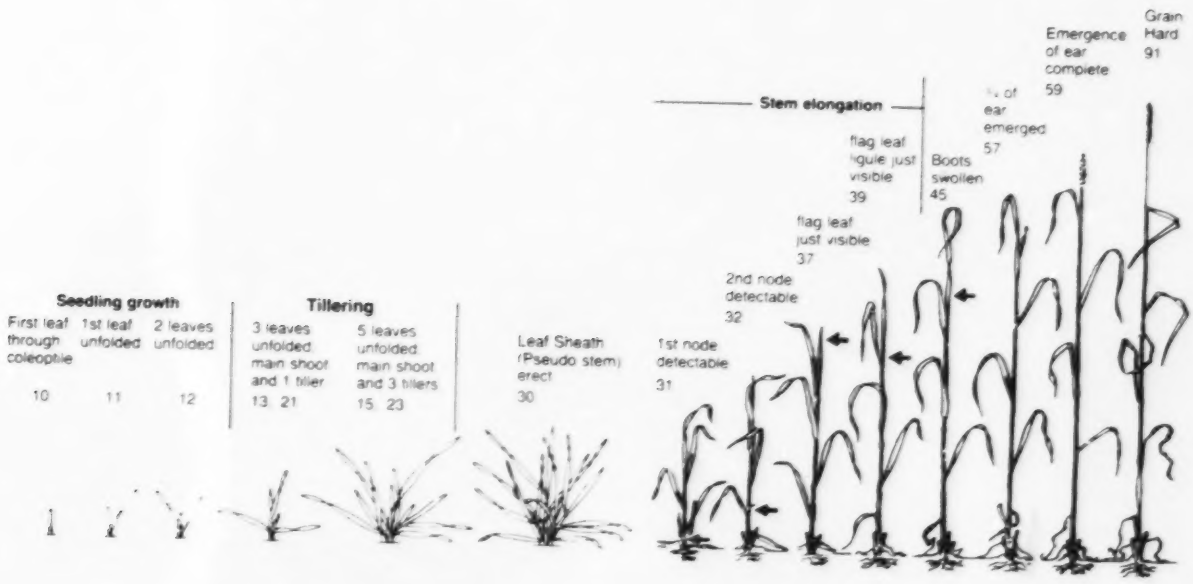
Figure 31 — Growth Stages of Cereals

Recommendations on the timing of herbicides, supplementary nitrogen, foliar applied plant growth regulators and fungicides are made so crops receive the required treatments at proper stages of growth for maximum benefit rather than by calendar date. In the Zadoks growth scale, plant growth is measured on a scale of 0-100. Growth is divided into 10 principle stages each of which is further subdivided into 10 stages.

Main Zadoks Growth Stages of Cereals

0-9 Germination
10-19 Seeding growth
20-29 Tillering
30-39 Stem elongation
40-49 Booting (first awns visible at 49)
50-59 Head emergence (complete at 59)
60-69 Flowering (half completed at 65)
70-79 Milk development (watery ripe at 71)
80-89 Dough development (dough hard at 87)
90-99 Ripening (harvest can start at 92 when seed not dented by thumb nail)

ZADOKS GROWTH STAGES IN CEREALS
Tillers have been omitted on the right



Underseeding

Highest grain yields are obtained by seeding and harvesting the crop with cereal production as the primary goal. Underseeding of cereal grains with grasses and legumes can reduce yields, but the benefits of this practice may sometimes have move overall impact on the farming operation than the yield reduction. Large acreages of cereals are grown in rotation with potatoes where soil conservation is a primary concern. Cereals alone do not provide soil restoration. Underseeding is a sustainable practice which assists in the conservation of soil moisture, soil physical characteristics and soil fertility. It can be successfully accomplished and provide a benefit on many farms. There are a number of factors which must be taken into consideration when underseeding. These are seeding rates of the cereal and the forage and the choice of the forage. Recent field scale experiments at the Charlottetown Research Station have shown the value of underseeding barley with red clover and certain varieties of annual ryegrass. There can be problems associated with underseeding. Mixed crops maintain moist conditions around the cereal plants increasing the chance of diseases and lodging. Weed control and fertility needs are usually different for cereals and forages. This makes proper management of both types of plants more difficult. Forages mixed in the cereals will increase combine problems if the cereal lodges and the forage grows above the cereal. These

problems are avoided if the correct cereal forage combination is seeded at appropriate rates. Cereal producers may wish to consider overseeding of forages into cereal stands after the herbicides have been applied as an alternate method of seeding forages. This practice will reduce the problems of weed control and harvest operations and, provided moisture is adequate for forage seed germination, a forage stand should establish.

This method, from a forage point of view, will be less successful than a direct seeding. If cereals are seeded down to forages, seeding rates for the cereal cover crop should be reduced by 50%.

Crop Nutrition

Plants require sixteen essential elements for growth and development. Nitrogen (N), phosphorus (P), and potassium (K) are required in the largest amounts. Calcium and magnesium are also required in significant amounts but are generally adequately supplied by a good liming program. The sulfur from the atmosphere and soil organic matter is usually adequate for good cereal yields under most conditions in the Atlantic region. There is little evidence of deficiency of other trace elements.

Lime

Most soils of the Atlantic Region are acidic because of their original parent material and the high annual precipitation which leaches elements such as calcium, magnesium and potassium, from the soil surface layer. On low pH soils, the efficiency of applied fertilizer and the activity of soil micro-organisms are reduced Figure 10. Soils of the Atlantic Region require frequent applications of ground limestone to maintain appropriate pH levels. The amount of lime required to reach optimum pH is best determined by soil testing. Dolomitic and calcitic limestone are equally effective in raising pH but dolomitic limestone also supplies magnesium to the soil. Cereals grow best when the soil pH is 6.0 - 7.0.

Figure 32 — Fertilizer Efficiency at various pH Values

Soil pH	Nitrogen Efficiency	Phosphorus Efficiency	Potash Efficiency	Overall Fertilizer Efficiency
pH = 6.0	89%	52%	100%	80%
pH = 5.5	77%	48%	77%	67%
pH = 5.0	53%	34%	52%	46%

When possible, soil pH should be corrected before fertilizer is applied. Liming in the fall and fertilizing the following spring is more effective than applying both lime and fertilizer in the spring. Lime applications made during the seeding year are of some benefit, but do not have sufficient time to be completely effective during the season of application. Surface applications of lime on emerged seedlings are of little immediate value. For best results, lime should be incorporated into soil to the depth of cultivation. For further details regarding lime see ATLANTIC SOILS NEED LIME, Pub. 534.

NITROGEN

In cereal production, nitrogen is essential for proper plant growth and for many of the processes within the plant such as photosynthesis and protein production. When cereals follow legumes in the rotation, considerable nitrogen may be available from the soil but fertilizer nitrogen is still required for top yields. Availability of nitrogen is generally the factor which limits cereal growth in the Atlantic Region. As availability of N increases, the rate of vegetative growth increases.

Farmers should be aware that there is a definite conflict in that higher rates of nitrogen will cause increased incidence of disease and lodging. When high levels of N are used in conjunction with fungicides for disease control and growth regulators for lodging control, splitting the N application may be beneficial. When multiple or split applications of N are used, it is important that the low rates of materials (e.g., 40 kg of N or 120 kg 34-0-0/ha) be applied uniformly. Use of pneumatic fertilizer spreaders in combination with tramlines has generally given superior results to those obtained with spinner type spreaders. If soils are high in phosphorus and potassium, as is often the case in potato rotations, good grain yields can be obtained by application of 60-90 kilograms per hectare of nitrogen alone.

For winter cereals, generally 2 - 3 applications of 30-60 kg N/ha are used. Early N applications are beneficial to yield while late N applied after heading will not influence final yield, but should increase protein content. For spring cereals up to two applications of 30-60 kg N/ha are used with later applications most useful in increasing protein content. The total amount of N a cereal crop can utilize depends on its yield potential. If other factors allow for high yield a crop can benefit from higher N levels. Nitrogen cannot overcome limiting factors such as drought, late seeding, or diseases and optimum N level will be lower under such conditions.

Phosphorus

Phosphorus is required for early growth, therefore, high levels are needed near the developing seedling root. Applied fertilizer phosphorus in most soils of the Atlantic Region remains primarily wherever it is applied. Higher rates of phosphorus are required where soil tests indicate low levels of available phosphorus, where little fertilizer has been applied recently, when the fertilizer is broadcast or cereals are seeded early into cold soils. Lower rates may be used on soils testing high in phosphorus and when fertilizer is drilled with the seed. The availability of phosphorus is most dependent upon soil pH for at low pH levels the phosphorus is held in a form unavailable to the plant.

Potassium

Cereal crops require potassium for good root development, kernel filling and lodging resistance. Higher rates are required on soils testing low in potassium or where little fertilizer or manure has been applied in recent years. Higher rates are required when straw from the previous crops has been removed, than when straw has been incorporated into the soil for a number of crops.

Fertilizers

Soil fertility can be improved by the addition of granular fertilizers, manure, cover crops and underseeding or various

combinations of these. The following recommendations refer to granular fertilizers. When using manure or other sources of fertility, the amounts required should be calculated based on the analysis of the material being used. Your provincial soils lab can assist you with specific fertility recommendations on an individual field basis.

Where Phosphorus (P) and Potassium (K) levels are high, moderate levels of fertilizer application (40-60 kg/ha) should be sufficient to maintain high P and K levels and under such conditions there is little difference between various methods of application. Where soil fertility levels are low-medium, moderate rates of fertilizer drilled beside and below the seed are more efficiently utilized than when broadcast. This is especially true of developing seedlings. Levels of banded fertilizer should not exceed 55 kg of N, 110 kg of P_2O_5 or 55 kg of K_2O per hectare. Where fertilizers containing urea and diammonium phosphate are major nitrogen sources, these rates should be decreased by approximately one-half. For further details, refer to "Soil Fertility Guide", Pub. No. 535-81 and table page 49, "Estimated Removal of Plant Nutrients by Various Crops".

Figure 33 — General Fertilizer Recommendations for Atlantic Grain Crops

Figure 33 — General Fertilizer Recommendations for Atlantic Grain Crops

Specific Recommendations Require a Soil Test

Crops	Conditions	Kg of Nutrients per hectare			Example Analysis	Rate (kg/ha)
		N	P_2O_5	K_2O		
Spring Grains Spring wheat, oats & barley (not underseeded)*	Very early seedings mid - late April:					
	At seeding	20-40	40-80	40-80	12-24-24	175 to 300
	Topdress	20-60	0	0	34-0-0	60 to 180
	Normal seeding at seeding/topdress	60-90	30-80	30-80	20-10-10	300 to 450
	Later seedings (late May, June):	50-80	25-80	25-80	20-10-10	250 to 400
Soybeans, peas	Incorporate or band (not with the seed) at planting	10-15	40-70	40-70	5-20-20	200 to 350
Buckwheat	At seeding	25-50	25-50	25-50	17-17-17	150 to 300
Winter Grains Winter wheat and rye[3]	At seeding	10-25	40-100	40-100	5-20-20	200 on fertile soils 300 to 500 on less fertile land
	Just before spring growth begins	30-75	0	0	46-0-0	100 to 125
	Growth stage 25-30 (end of tillering)[1]	25-30	0	0	46-0-0	75 to 125
	Growth stage 39-45 (boot to heading)[2]	30-60	0	0	34-0-0	100

*Reduce the N on underseeded crops to 1/2 the above rates; P_2O_5 and K_2O should remain the same.

For above crops:
Use the lower rates of P_2O_5 and K_2O where manure, lime and fertilizer have been regularly applied. Use the higher rates if applications have been infrequent.

1. This application should be increased to 40-60 kg N/ha where a final application at Growth Stage 39-45 is NOT planned.
2. This application will raise grain protein of wheat. Response will be limited on rye. Yield increases are limited. Tramline systems or aerial applications are necessary to prevent crop trampling.
3. The higher rates may cause excessive lodging of rye.

Fertilizer Ratios and Analyses

The best fertilizer to use in a given situation depends on the amounts of nitrogen, phosphorus and potassium required. Results of analysis of soil samples are the best indicators of the required fertilizer, ratios and analysis for a given crop on a given field. When soil test results are not available, general guidelines should be followed.

For general conditions of low to medium levels of phosphorus and potassium, a 1-1-1 ratio is recommended. Commonly available fertilizer with 1-1-1 ratios include 17-17-17, 15-15-15 and 10-10-10. All are generally satisfactory, although handling properties may vary depending on nutrient sources used in their manufacture. The higher analysis materials are generally more economical per unit of plant nutrient. Three hundred thirty-five kilograms per hectare of 17-17-17, 370 kilograms per hectare of 15-15-15 provide 56 Kilograms per hectare each of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O). These are the maximum

rates of nitrogen and potassium which can be safely drilled in with the seed, providing the source of nitrogen is not urea or diammonium phosphate.

For winter cereals, fertilizer with a 1-4-4 ratio such as 5-20-20 are generally recommended for fall application, followed by a broadcast application of nitrogen in early spring and subsequent applications at later growth stages.

When high rates of phosphorus are required with medium rates of nitrogen and potassium, fertilizer with a 1-2-1 ratio such as 10-20-10 or 8-16-8 may be used. Where high rates of nitrogen and low to medium rates of phosphorus and potassium are required, fertilizer with a 2-1-1 ratio such as 20-10-10 may be used. If these mixtures are not readily available and since they may be difficult to handle under moist conditions, it may be better to apply sufficient 1-1-1 ratio fertilizer in the drill to meet phosphorus and potassium requirements and broadcast the additional nitrogen as ammonium nitrate (34-0-0) or urea (46-0-0).

Pest Management

Pests, including weeds, insects and diseases, are major limiting factors in the production of high yielding, high quality grain crops. While potentially destructive, the full impact of most pests can be significantly reduced by a number of preventative and curative methods. These involve the major areas of government regulation, appropriate crop management, resistant varieties and chemical control. The integration of several of these methods provides the best results.

Regulation

Numerous regulations are present which assist in preventing the introduction of new, or more difficult to control pests, into the Atlantic region. These are administered by Federal or Provincial regulatory agencies for the protection of individual growers and the entire grain industry. An example of such regulations for pest control is the licensing system for new varieties which requires oats to be resistant to Victoria blight, a very destructive disease which has been eliminated by requiring all new oat cultivars to be resistant. Another illustration may be cited in the Pedigreed Seed regulations which limit weed seed content in seed grain and requires the complete elimination of specified noxious weeds from certified seed.

Crop Management

Crop rotation and other good crop management techniques such as early seeding are effective methods for pest control. Each additional year a field is in continuous cereals increases the number of weeds, disease causing fungi, and insect pests present which are detrimental to yield. Examples of such situations includes: the gradual buildup of grass weeds (particularly quackgrass), increased diseases such as Take-all, Fusarium head blight and insects in continuous cereal fields. A break crop denies these pests the hosts they require, resulting in a decline in their population. A significant yield loss due to pests may occur in the second year that cereals are planted in a field. Barley after barley has been shown to lower yields by up to 500 kg per hectare.

Pests can be quite mobile and crops to be seeded in adjacent fields must also be considered. This is a particular consideration in the spread of the fungus inciting powdery mildew on wheat. If winter wheat is infected in the fall, it may infect a susceptible spring planted wheat shortly after emergence in an adjacent field. If spring wheat can be planted at a distance from the winter wheat, infection will be delayed until a more advanced stage of growth on the spring wheat and thus lessen disease severity.

Integration of pest control can best be illustrated by the value of controlling grass weeds such as quackgrass in cereal fields. Quackgrass is an alternate host of the fungus causing Take-all, a severe root and basal stem disease of cereals, particularly wheat. When the weed host is eliminated, the population level of the disease causing pathogen is reduced and less disease occurs in the cereal crop. The quackgrass must be destroyed by the spring prior to planting winter cereals or the fall prior to seeding spring cereals.

In those areas where soil erosion is not a problem, fall plowing to bury crop debris will assist in the decomposition of the residues on which disease causing fungi and insects survive between grain crops. Early decay of such plant materials in the fall will reduce the overwintering of many pests.

Resistant Varieties

A resistant variety should always be used whenever possible. Resistance many not be total and some disease symptoms may develop but even partial resistance may reduce the yield loss. Many cultivars are susceptible to a number of diseases, however if resistance is present to even one, this is still of value in those years or circumstances when that one disease may be prominent.

Herbicides

Weeds compete with grain to reduce yield and large weed plants cause difficulty during combining. Weed competition starts very soon after emergence of the crop and weeds. One or two weeds per square meter will not cause serious yield loss, but they do act as a source of weed seeds that will contaminate the field for the next growing season. Also, individual plants of large vigorous weed species such as lamb's-quarters and wild radish will cause yield loss of grain plants located in the vicinity of the weed plant. Research is under way to develop "threshold" levels for the number of weed plants per given area. A "threshold" is that number of plants above which yield reductions can be expected. For example, in western Canada, 9 plants of wild oats per square meter will reduce barley yield by more than 5%. The "threshold" value can be used to determine if it is necessary to control weeds to achieve maximum yield. Weeds have their greatest competitive effect early in the growth period of the crop. Removal of the weeds for the first few weeks after crop emergence is usually all that is necessary to ensure maximum yields. Weeds that emerge later in the summer are usually not very vigorous as they are suppressed by the taller growing cereal crop. Research is underway to determine more clearly this critical weed free period for cereals in the Region.

Weeds can be reduced by management practices in grain production. Use of crops in the rotation that smother weeds and reduce or prevent weed seed formation will reduce weed problems in the following grain crop. Use of a stale seed bed technique before planting grain will also help to reduce weed problems. In this technique, the soil is prepared for planting but left for a few days to let weed seed germinate and weeds emerge. The soil is then shallowly cultivated to kill this first flush of weeds and the grain crop is planted. Removal of the first flush of weeds removes early weed competition but success is dependent on many factors. Once the crop and weeds have emerged then cultivation between the rows when the weeds are very small in the cotyledon to first leaf stage will help to reduce the weed infestation and competitive effect on the crop. Several mechanical vibrating rod type weeders are available today for mechanical weed control in grain crops.

Herbicides can give good weed control but must be accurately selected to control the weeds present in the field.

Herbicides should be considered a production tool and not a cure-all for poor management. Young, rapidly growing weeds are more easily destroyed than large older weeds. Consideration should be given to using tramlines when herbicides are post-emergent applied as this will result in less damage to the crop and give greater application accuracy. Late spraying gives poor weed control and may reduce yield due to crop injury; most yield depression due to weed competition occurs during the early stages of crop and weed growth.

Quackgrass infested fields should be cleaned up before seeding cereals. Do not neglect grain fields after harvest, but use shallow cultivation as well as herbicides to control quackgrass and other weeds. Success of weed control with herbicides depends on proper application. Read and carefully follow the instructions in production guides and on the product label.

Insecticides

Population of insects such as armyworms and aphids may build up very rapidly and producers should regularly inspect their fields to detect such increases before they reach a level at which control is difficult or the crop is already damaged. Control of aphids will also reduce the harmful effects of barley yellow dwarf virus which is aphid transmitted. Early seeding will effectively reduce the importance of insects as the host crop in early seeded fields will be more advanced in growth when attacked and thus less liable to severe yield loss. It is frequently difficult to determine when an insect population has reached a level at which use of an insecticide will be warranted and in such instances grower and crop specialist's experience is helpful. Under certain conditions, use of an insecticide seed treatment provides sufficient protection from some insects and eliminates the requirement for a foliar applied insecticide. In order to select the proper insecticide, careful observation and identification of the insect pest in question is required.

Information on the relative disease resistance of recommended varieties for the Atlantic Region and on specific pesticides can be found in Publication 100A published yearly.

Disease Control

Diseases are major yield and quality limiting factors in the production of successful grain crops. Most cereal diseases which occur in the Atlantic Region are incited by fungi or molds but others are caused by viruses, bacteria or nematodes. While potentially destructive, the full impact of most diseases can be significantly reduced by preventative and curative practices.

Such practices involve government regulation, preventative crop management techniques, use of resistant cultivars and fungicide treatments. The integration of all suitable methods usually provides the most cost-effective system, depending on the current market price situation for the particular cereal crop.

Grain producers are encouraged to examine their crops on a frequent schedule and have a practical knowledge of diseases. The knowledge required by grain producers must include the ability to recognize diseases and their symptoms at an early stage. The severity of the symptoms must also be assessed in order to quantify potential damage. (See Figure 34) A 0 - 9 scale for measuring disease severity is also used in establishing the level of disease resistance recorded in lists of recommended cultivars for the region, which is updated annually in Publication 100A. Understanding the method of spread of pathogens also will assist in estimating the final severity of crop damage. Most virus diseases of cereals are transmitted by aphids and in such instance, aphid control constitutes an essential part of disease control. Finally, understanding the environmental conditions influencing the development of a potential epidemic will help determine the value of applying chemical treatments.

Crop Management

1. Provision of optimum growing conditions in terms of field selection, soil drainage, soil pH, tillage, fertilization rate, proper seeding rate and depth and early planting dates.
2. Respect for legislation designed to exclude new pathogens or new races of existing pathogens. Such regulations prevent the importation of unregistered seed lots of cultivars. This eliminates the problem of introduced pathogens which may not be controlled by existing levels or types of disease resistance.
3. Crop rotation is essential to reduce the severity of diseases and helps to suppress weed and insect damage to crops. Crops should be diversified as much as possible within individual farms and within a region to help overcome the build-up of aerial transmitted diseases. The collective crop health within any region of the Atlantic Provinces is governed by the success of each individual producer in reducing the build-up of disease organisms. Crop rotation for disease control requires a knowledge of host ranges of the pathogen in question, as frequently, a cereal pathogen will attack and survive on different species of crops which may be used in rotations. Corn should not be rotated with cereal crops because both are hosts to a number of fungal pathogens (e.g. fusarium), which increase in severity when these crops are included back-to-back in rotations.
4. Field hygiene is essential in order to reduce the survival of disease inciting pathogens. This, in conjunction with crop rotation, is particularly important in controlling foliar pathogens of cereals and recommended action includes the proper and timely soil incorporation of crop debris or stubble and control of alternate hosts of pathogens such as perennial grass weeds.

Fungicides

Fungicide seed or foliar treatments should be considered only after an assessment of the severity of the diseases in question and yield potential of the crop has been made. In deciding if a seed treatment is required, consider the disease susceptibility of the cultivar in question and the potential for planting in a relatively warm soil, which will enhance emergence. Foliar diseases should be assessed for severity in the field prior to application of all foliar fungicides. (See Figure 34)

Fungicides should be applied at the recommended rate and time. Reduced rates should never be considered since this tends to favor development of insensitive types of the pathogens whereby the fungicide looses it's ability to control diseases. This is believed to occur by the removal of sensitive strains of the pathogen, leaving an already present resistant minority strain to develop unhindered by competition. The repeated use of the same fungicide also leads to insensitivity. Fungicides for powdery mildew control have been recorded to loose their effectiveness after repeated use for some 10 years. For this reason, do not apply a fungicide unless all other appropriate methods have been utilized and have not reduced disease severity to an acceptable level. When possible and necessary, a second application of fungicides should use a different chemical than that which was applied for the first application. The success of control should always be monitored so that the need for corrective application procedures may be determined for future use.

Figure 34 — Scale (0-9) for measuring severity of foliar cereal diseases.

	INTENSITY OF SYMPTOMS ON LEAVES FOR EACH SCORE*									
	0	1	2	3	4	5	6	7	8	9
Upper Leaves	Free	Free	Free	Free	Isolated	Isolated	Scattered	Light-moderate	Moderate-severe	Severe
Middle Leaves	Free	Free	Free	Isolated	Scattered-light	Moderate	Moderate	Severe	Severe	Severe
Lower Leaves	Free	Isolated	Scattered	Light	Light-moderate	Moderate-severe	Severe	Severe	Severe	Severe

*Area of leaves covered by symptoms: Free = 0%, Isolated = 1%, Scattered = 5%, Light = 10%, Moderate = 25%, Severe = 50% or more.

Figure 35 — Conditions most likely to lead to development of cereal diseases in the Atlantic region.

CONDITION	DISEASE INFLUENCED	HOST
Spring cereals:		
Cool wet planting season	Increased scald	Barley
Excess rain early to mid-season, humid conditions	Increased net blotch, septoria diseases Reduced powdery mildew	Barley, wheat Wheat, barley
Excess moisture from heading to maturity	Increased septoria glume blotch Increased fusarium head blight	Wheat Wheat
Excess moisture at harvest	Increased sooty molds, lower seed quality, increased lodging	All cereals
Dry, hot conditions	Reduced foliar and head diseases, increased symptoms of Take-all and other root rots	All cereals All cereals
Winter cereals:		
Excessive, long lasting snow cover	Increased snow molds	Winter wheat and rye
Lack of mid-winter snow cover	Reduced winter survival	Winter wheat and rye
Wet (delayed) planting	Reduced fall growth and winter survival	Winter wheat
Early planting	Excessive foliar diseases	Winter wheat

Figure 36 — Procedure for determining if a fungicide should be applied to cereals for disease control.

Identify disease and severity
Determine disease reaction of cultivar
Ascess potential of success of non-fungicide methods
Estimate potential yield & profitability of crop
Estimate treatment cost and potential for yield increases
Determine maturity and estimate days to harvest

RECOMMENDATION

YES, TREAT | WAIT AND SEE | DO NOT TREAT

Combining

Grain losses due to improper combine adjustment and operation have occasionally been found to be as high as one third of the total yield. Such losses were determined on the basis of actual combine yield before and after proper adjustment of the machines. Grain losses can be detected by examining the ground behind the combine, and by sampling the straw walkers and the sieves using a small window screen. This determines the location and extent of losses and the operator should then correct these.

Header

For best feeding of the grain, adjust the reel speed to be slightly faster than the ground speed of the combine. This will keep the front of the grain head clear of grain and will prevent plugging. If reel speed is too fast, cut material may be carried around the reel. Adjust the reel height so the reel bat contacts the grain just below the heads so the reel will not wrap or shatter.

Tailings

Next you should check a sample of material coming up through the tailings return elevator. If grain is not being threshed from the head, it may be necessary to increase cylinder speed or decrease concave clearance, or both.

If an excessive amount of threshed grain is present, the adjustable sieve may need to be opened to allow grain to drop through, as these will be carried by the clean grain elevator up into the grain bin.

Grain in bin

After a good sample of the grain is in the bin stop the combine and check it. If grain is being hulled or cracked, reduce cylinder speed or increase concave clearance, or both. If an excessive amount of chaff and other lighter foreign material is in the grain bin, the fan choke opening should be increased slightly. Chaff and other light material can also be reduced by closing the sieve and reducing the chaffer openings slightly.

Unthreshed heads in the grain may occur because the adjustable sieve is opened too wide. Also, the cylinder speed

may be too slow or the cylinder-to-concave clearance too wide.

Straw behind combine

Lastly, check for grain in and under the straw. Grain loss at this point can result from the straw walkers being overloaded due to too high a feed rate, improper straw walker speed, or damaged check flaps. If straw matting on walkers is a problem, then add additional riser fingers or fishbacks.

Loss can also occur from grain being blown over upper sieve by too much wind or chaffer not open far enough.

Grain loss monitors are available which indicate grain being lost over the straw walkers and cleaning sieves. The monitor must be calibrated properly.

Combines are designed to work on level ground. Sloping ground reduces the combine's cleaning and separating ability and increases losses significantly, especially during side-hill and up-hill operation. On sloping ground reduce forward speed to reduce losses.

Protein Crops

Introduction

The Atlantic Provinces require increased production of protein crops to support the existing livestock industry in the region. Acreages of protein crops are increasing, but there is a need to maintain this trend. The principal protein crop in the region is soybean but there is increasing interest in sweet white lupin. Canola, faba bean and field peas can also be grown.

SOYBEANS

Soybeans are adapted to the longer frost free areas with climatic conditions similar but not necessarily identical to those for grain corn. Early maturing varieties produce average yields of over 2.0 tonnes per hectare with protein contents of 35 to 40 percent. Raw crushed soybeans may be included as a protein supplement in dairy and beef cattle rations without further processing but some form of heat treatment such as roasting or extrusion is required before soybeans can be fed to poultry or hogs.

Several soybean varieties which can reach maturity over much of the Atlantic region are now available. Soybeans make a good rotation crop, particularly for cereals since they break disease cycles and leave fixed nitrogen in the soil. They have potential in many cropping programs in the Atlantic Region particularly on livestock farms.

Soil and Fertilizer.

Soybeans should be planted in well drained fields with high residual fertility and a pH of above 5.6 and preferably over 6.0. Their response to fertilizer application is generally low but specific requirements for both lime and fertilizer should be determined from soil tests. Fertilizer for soybeans should be broadcast and harrowed in before seeding. Drilling fertilizer directly with the seed can seriously reduce stands. Manure can be applied to fields in the fall or spring prior to soybean planting. Soybeans have a high demand for nitrogen and can absorb large quantities without any adverse effects on the crop.

Varieties.

Breeding programs for soybeans in Guelph and Ottawa have given Maritime farmers a choice of varieties well adapted to local conditions. Choose a variety which will mature under the conditions which prevail on your farm. These include the climatic conditions and management considerations. Protein content and sensitivity to herbicides should also be considered. For detailed descriptions of the varieties and their characteristics, consult Field Crop Guide to Variety and Pesticide Selection, Publication 100A.

Seed Quality.

Locally produced pedigreed seed or home grown seed which has been properly stored and tested for germination are the preferred choices. When using seed from outside the region it must be certified and be from an area which is free of soybean cyst nematode. Never use old seed. Soybean seed should always be handled carefully. Rough handling causes cracking and reduced viability even when there is no cracking. High vigour seed is especially important for early seeding in cool soils.

Inoculation and Seed Treatment.

Soybeans require inoculation with specific soybean rhizobium when seeded in fields which have not grown soybeans before. Once soybeans are established in a crop rotation, inoculation is not generally required since the bacteria remain in the soil in great numbers.

Inoculum is available in a granular form or as a powder in peat. Granular inoculant is applied in the seed row, powdered inoculant is applied as a seed treatment. A sticker will help to ensure adhesion. When properly applied, both are equally effective if they have been correctly stored. **Prolonged exposure to heat and light decreases the effectiveness of the inoculant.**

Seed treatments with insecticides and fungicides can be detrimental to the rhizobium inoculant. Soybean seed should only be treated if conditions indicate that there might be a disease problem. Treated seed should be inoculated immediately before planting. If seed is not planted the same day as it is treated it must be re-inoculated. Early planting in cold soils will benefit from a seed treatment.

Seeding Methods and Rates

A firm level seed bed should be prepared using as few tillage operations as possible so that soil structure is maintained and compaction minimized. Light landleveling before and rolling after seeding is recommended to facilitate easier harvesting of lower pods especially on unlevel ground. Soybeans are usually seeded with a grain drill in seven inch rows at 100 to 150 kg per hectare. The lowest rate is sufficient for optimum conditions of seed quality, depth and spacing control. The grain drill must be carefully adjusted to prevent seed cracking and to deliver the seed to the preferred depth of 2.5 to 3.5 centimeters. Since seed is one of the higher input costs in soybean production these factors are very important. Some soybean varieties can compensate for differences in plant stand without adversely affecting yield.

Soybean seeds germinate when the soil temperature reaches 10 °C. Contrary to popular belief, the soybean is quite resistant to frost. Planting should take place between May 10 and May 31, depending on local conditions.

Weed Control

Good weed control is essential to successful soybean production. The plant cannot compete with broadleaf weeds, annual grasses or quack grass since it emerges slowly and takes several weeks to establish ground cover. Both mechanical and chemical weed control are appropriate for soybeans and your choice should depend on the weed problems and other farm management factors. For example, planting in 7" rows precludes mechanical weed control other than the use of a rotary hoe or other shallow cultivation in the very early stages of crop development.

Herbicides are available and recommended for controlling both broadleaf weeds and grasses in soybeans and should be selected for control of specific weeds present. Growers should select their best fields which have low weed populations. Fields should be selected the year before soybeans are to be grown so that weeds can be identified and herbicide programs selected that will give control of the weed species present. Atrazine residue can severely injure soybeans. Select fields which have not received more than 1.7

kg/ha of atrazine the previous year. Proper time of application of each herbicide is stated on label and in production recommendations. Growers should consult these and follow recommendations carefully, as in many cases, the margin between adequate weed control and crop damage is narrow. Refer to Publication 100A for specific weed control recommendations.

Diseases

Soybeans grown in the Maritimes have been relatively free of pest & disease problems. Any observed diseases have not caused significant losses. White mould, bacterial blight and stem canker have occasionally been observed and could become more threatening under conditions of stress or monoculture.

Harvesting and Storage

Soybeans are ready for harvest soon after leaves turn brown and fall off. This generally can be expected in late September or October, depending on seeding date, variety and growing conditions. Moisture levels should be below 20% for harvest. Combines should be adjusted according to manufacturers specifications to obtain a clean sample of undamaged beans. Generally, lower cylinder speeds (500-700 rpm) and wider concave and seive openings are required for soybeans than for cereals. Care must be taken to harvest bottom pods which are close to the ground. Flexible cutterbars and level fields improve the ability to harvest bottom pods.

Safe moisture levels for storage depends on air temperature and volume stored. For summer storage, moisture levels should be less than 12%. For short term storage, soybeans may be held at moisture levels up to 18%, if the bins are adequately aerated.

Uses

The major use for soybeans produced in the Atlantic region is as a protein supplement for livestock feed. For ruminants, they may be used directly using normal milling practices for small grain with some modification to avoid excessive oil coating of milling equipment and to avoid rancidity in the oil following crushing. For feeding to non-ruminants, soybeans require heat treatment to destroy digestion inhibitors. Before soybeans are introduced to a feeding program, a livestock nutritionist should be consulted to ensure that a properly balanced ration is used.

CANOLA

Spring canola is well suited to the cool, moist growing season and tolerant of the varied soils of the Atlantic Provinces. To date, this crop has only been grown on a small commercial scale in Nova Scotia, since 1982. On the 75-100 hectares of spring canola grown annually, an average yield of 1.5 - 2.4 tonnes/hectare has been achieved. Smaller hectarages of winter rapeseed have produced similar yields, providing winterkill damage was not significant.

Canola has the potential to be an important cash rotation crop for cereal farmers if current local processing and marketing limitations can be resolved. Its use in cereal rotations breaks disease cycles and results in improved cereal yields.

Soil & Crop Management

Canola is an extremely fast growing and massive crop that really responds to good management practices. Key components of production are proper soil fertility, disease control and good harvest management during desiccation/combining. To achieve the rotational benefits canola has to offer, the following points should be considered. Canola fits well into a rotation with grass forage and any of the cereals. This crop does not harbour the common root or foliar diseases that affect cereals. Canola utilizes manure well as a nitrogen source, the slow nutrient release from solid manure and bedding materials is suited to canola which requires the bulk of its nitrogen 6-8 weeks after seeding.

Canola should not be grown in short crop rotations with beans, peas, soybeans, carrots, potatoes and alfalfa due to the Sclerotinia stem rot (white mould) fungus which is a common problem with these crops. Canola should also not be grown in crop rotation with cole crops (i.e. cabbage, cauliflower, rutabaga, etc) because of common disease susceptibility to clubroot and Alternaria black spot.

General Seeding Information

In growing canola, it is very important to have a fine, firm seedbed. Rolling, both before and after seeding, is sometimes advisable on loose ground. Good seed - soil contact must be made to ensure canola gets a quick start on hard to control weeds such as wild radish or mustard.

Generally, canola is seeded from mid-May to early June after the cereal crops are in, and soils are warmer. The seeding rate of 8-10 kg/ha is optimal at a 1-2 cm, uniform depth placement. Canola does the best in a 7-20 cm row spacing when seeded with a grain drill. However, a Brillion-type seeder or broadcaster can be used as well.

Although there are different types of both spring and winter canola, farmers in our region have concentrated on a higher yielding Napus type (Argentine). The results of local variety trials indicate that the Napus type, such as Global and Topas out-perform the standard western varieties (Polish type) such as Westar and Regent. It is common practice to use pre-treated seed containing an insecticide/fungicide combination to control flea beetles and seeding blight.

Fertility

Canola generally shows an economic yield response to an application of 80-100 kg/ha actual Nitrogen. A split application (20-30% at seeding and the remainder at growth stage 3, prior to bud development) seems to be the best fertility strategy for this crop.

Due to the large vegetative structure of canola, it requires a reasonable amount of both Phosphorous and Potassium for good root system development and proper growth/photosynthetic functions, respectively (refer to Table 6).

Canola requires higher levels of Boron than cereals. Soil levels of 1-2 ppm is generally considered adequate. Appiy a kg/ha actual Boron in absence of a soil test.

Canola is a heavy user of Sulfur and deficiencies of this nutrient have appeared in the region in the past. The plants, at first, appear to be a pale, green color similar to what would be expected for Nitrogen deficiency. The underside of the upper leaves may turn a purple-red color and become cupped just prior to flowering when demand for Sulfur is greatest. Pods may be shrunken and yield can be cut significantly in some cases. Crops grown on sandy, low organic soils are at the most risk.

The most efficient way to supply Sulfur is a foliar application of Sulfur (ie. Kumulus S applied at 5 kg/ha) at growth stage 3 or before if deficiency symptoms appear.

The soil pH for canola should be 6.0 or higher for best results, although canola will grow better than most other grains at pH's as low as 5.4.

Figure 37 — Soil Nutrients Used by Canola Compared to Barley & Wheat

Crop	Nitrogen kg/ha	Phosphorous kg/ha	Potassium kg/ha	Sulfur kg/ha
Spring Wheat (2.7 t/ha yield)	95	33	72	12
Barley (3.2 t/ha yield)	101	34	97	13
Canola (2.0 t/ha yield)	118	52	93	23

*Source - Grow With Canola, Canola Council of Canada, Winnipeg.

Weed Control

Select clean fields and control perennial grass problems in the fall prior to seeding with an appropriate herbicide. For pre-plant and post-emergent herbicides, consult the Guide to Weed Control, Publication 75. Once a good crop of canola is established, few weeds will compete with it.

Insects

Flea beetles are probably the most serious known pest at this time. If at 2-3 weeks the leaves on the small plants have a "shot-holed" appearance and 25% of cotyledon area is destroyed, a spray is warranted. If you are using a post-emergent insecticide spray then or later, consult your crop specialist to determine which treatment is effective and compatible with bees and other advantageous insects.

The best approach to insect control is the incorporation of a granular insecticide at planting time. The insecticide is mixed with the seed and provides control of many insects during the first few critical weeks of growth. Care must be exercised when handling these materials as they are extremely toxic.

Diseases

White Mould (Sclerotinia) is the main disease of canola that has been identified at this time in Nova Scotia. It is characterized by bleached stem lesions, white mould fungus inside the stems, and by pre-mature ripening of the plants. As previously mentioned, the disease is especially a problem when canola follows canola, soybeans or peas. Use clean seed and rotations of at least four years including unaffected crops such as corn, small cereals and grass forages. Wet weather before flowering time increases the risk of white mould.

Alternaria Black Spot (Grey Leaf Spot) and other foliar diseases are also a problem in Canola, to a lesser extent in this region. These diseases destroy valuable photosynthetic area in the leaf and ultimately reduce yield.

Consult your crops specialist for information on disease control measures.

Pollination

Bees are useful for pollination although the Napus type of Canola is 70% self-pollinated.

Harvesting and Storage.

For direct combining, desiccation or topkilling is recommended, consult your crops specialist for information on registered top killers. Harvest must take place about 3-5 days from spraying otherwise losses due to shattering become unacceptable. Care must be taken to minimize shattering when applying the desiccant, a tractor with high clearance should be used. A harvest moisture of 13-18% is considered acceptable. Ripe canola thrashes very easily but it is important to adjust the combine according to the instructions in your operators manual.

Canola must be 9.5% moisture for long term storage. Aeration will keep it cool prior to drying, but large volumes of air and high pressures are necessary. Canola must meet at least Canada # 2 & # 3 standards for export and domestic use, respectively. Wind cleaners will remove light weight trash, but heavy objects such as small grains must be screened out. A spiral cleaner works well for canola.

Processing & Marketing

Between 1982 and 1989, locally produced canola was either exported overseas or transported to Ontario for oil extraction. A pilot processing plant is now in operation in Nova Scotia which can produce oil and meal for local livestock feed rations. Developments to this process may allow the production of oil for human consumption. If this occurs, canola could become a much more important crop in the Atlantic Provinces.

Significant portions of this section have been taken from "Spring Canola", a Nova Scotia Department of Agriculture Factsheet 1986. For specific rates on various crop management components, please refer to this Factsheet & your Crop Specialist.

FIELD PEAS

Peas are well adapted to the cool Maritime climate. Average yields of 2.0 tonnes per hectare of dry field peas are being obtained with protein content about 23 percent.

Peas are a legume that should be grown on well drained soils free from quackgrass. Early to mid-May seeding is recommended to ensure maturity and to reduce disease infections.

A seed treatment of a fungicide and insecticide is recommended.

Field pea rhizobia does not occur naturally in the soil and therefore inoculation is necessary where peas have not been grown within the last five years.

Seeding Rate

Small seeded peas should be sown at 135 kg/ha, medium sized peas sown at 200 kg/ha and large seeded peas sown at 225 kg/ha.

Further details regarding production of field peas are included in Growing Field Peas in the Atlantic Provinces, Publication No. 120.

LUPINS

Sweet white lupins are a long season crop adapted to well drained, sandy soils with a long frost free period. Yields in the range of 1.5 to 3 tonnes/hectare with protein contents ranging from 28-40% have been reported for the region. Lupins may be fed without heat treatment, but may require drying. Experience with production and utilization of sweet white lupins is limited in the Atlantic Region. Check with your local agricultural representative for the latest information on lupins.

Soil and Fertilizer

Lupins germinate and grow at lower temperatures than soybean, thus can be planted earlier in the spring for maximum yields. High levels of nitrogen appear to promote excess vegetative growth and delay maturity, thus soils with low N status are preferred. Vigorous vegetative growth and delayed maturity may also promote disease development.

Lupins are more tolerant of low pH than most other legumes and produce satisfactory crops at pH as low as 5.4. Generally, fertilizer application is not recommended, although P and K removed in the crop should be replaced in the rotation to prevent soil nutrient depletion.

Varieties

There are currently no varieties registered for production in Canada. Commercial seed of sweet white lupins is available. Care should be taken to ensure that seed used is of high vigor and that alkaloid levels are low.

Inoculation and Seed Treatment

Inoculation with a specific lupin inoculant is required for good N fixation, particularly when lupins are grown in a field for the first time. Care should be taken that the inoculant is specific for lupins and has been properly handled to ensure a high level of viability.

No chemical seed treatments are currently registered, hence use of high quality seed is essential.

Seeding Methods and Rates

Early, shallow seeding at 120 to 180 kg seed/hectare is recommended. Higher rates should be used on sandier, lower fertility soils with lower seeding rates on higher fertility, finer textured soil conditions. Grain drills should be carefully adjusted to ensure seeding depth of 2-3 cm and to prevent cracking of soil. Broadcast seeding with careful incorporation to ensure shallow (2-3 cm) seed placement may also be used.

Weed Control

Weed control is an essential step in obtaining a productive crop. Mechanical weeding or herbicides can be used separately or in combination. Effective pre-emergence herbicides are available for use on lupins. If weed pressures are low, lupins can generally compete well. Fields with high weed pressure such as heavy quackgrass infestations and high populations of perennial weeds such as goldenrod should be avoided. As with soybeans, site selection the year before is desirable so that weeds can be identified and an effective control program selected.

Diseases

Several seedling, root and seed diseases may attack lupins. Risk of serious disease loss can be reduced by use of high quality seed, long rotations and by avoiding wet soil conditions. Sclerotinia (white mould), Ascochyta and Rhizoctonia have been isolated from lupins in PEI but knowledge of the impact of diseases on lupins in the region is limited.

Harvesting and Storage

Maturity of lupins varies greatly with weather and soil conditions and is very sensitive to seeding date. Clean mature lupins are easy to harvest and with adequately adjusted combines, a clean product should be produced. Lupins can also be combined in a partially mature state (at moisture content exceeding 30%) but careful attention to drying and handling is required to prevent spoilage. Care must be taken to accurately determine moisture content of seed to ensure safe storage. The heavy, fibrous seed coat may dry more rapidly than the internal portion of the seed, thus the seed may appear to be drier than its true moisture content. Care must be taken in calibration of moisture meters to ensure accurate moisture readings.

Uses

Lupins may make an important contribution to the protein requirements of livestock. Since lupins vary in protein content and since levels of methionine and lysine are generally lower than those found in soybeans, care should be taken to ensure livestock rations are properly balanced.

Industrial uses of lupin hulls are not yet well developed in the Atlantic Region.

Pesticides

General Information on Use of Pesticides

All pesticides are poisonous to some degree. Because of their toxic effects, they should be treated with great care. Every chemical pesticide has the potential to cause serious illness if handled improperly.

A great proportion of the accidents involving chemical pesticides result when the user has ignored the warnings on the container label. Detailed directions, recommendations, and warnings are provided, by law, on the container label of commercial products.

For your own safety: *Always read and follow the directions, conditions, and limitations described on the label. If the label is damaged and illegible, do not use the product.*

Different companies often use different brand names for the same pesticide (Sencor and Lexone are brand names of commercial products containing metribuzin). However, different brands may have different concentrations of active chemical in them. Care should be taken to assure that the amount of commercial product used will provide the correct amount of active material. The amount of commercial product required will vary depending on the amount of active material to be applied and the formulation (concentration) of the commercial product. The Table below may be used as a guide to determine the amount of commercial product required to obtain a given rate of active material.

Calibrate your sprayer at least twice during the growing season. The wear on nozzles and other parts will alter the amount of spray delivered at the usual rate of speed and pressure.

FIGURE 38 — PESTICIDE DILUTION*

Pesticide formulation	Desired rate of ACTIVE material (kg/ha) 0.25	0.5	0.75**	1.0	2.0
WP	**Amount of formulation required/ha - - - - kilograms (kg) - - - -**				
(wettable powder)					
25%	1.0	2.0	3.0	4.0	8.0
50%**	0.5	1.0	1.5**	2.0	4.0
80%	0.31	0.63	0.94	1.25	2.5
Active/litre	**- - - - - - litres - - - - - -**				
250 g	1.0	2.0	3.0	4.0	8.0
500 g	0.5	1.0	1.5	2.0	4.0
1000 g	0.25	0.5	0.75	1.0	2.0

*To be used as a guide only. Consult the product label for exact rates. Appropriate English units may be substituted (see page 46).

**For example: If you required 0.75 kg active/ha (2/3 lb active/ac) and the pesticide chemical is a 50% WP (wettable powder) then you would apply the formulation (product) at 1.5 kg/ha (1 1/3 lb/ac) in order to apply the recommended rate of active material.

Disposal of unused (still in the container) and excess (already mixed, but not needed) pesticides is a critical problem, particularly if you have a large amount of unwanted chemical. At present, there is no simple solution to this problem.

The best precaution against pesticide disposal problems is good planning. Pesticide users should prepare only sufficient spray mixture to serve a specific purpose. Unused spray mixture should be disposed of safely. Pesticides must never be disposed of in waterways, sewers, ditches, or on land subject to flooding.

Residues on Crops to be Harvested or Fed or Grazed

Certain pesticide residues disappear quickly after application; others persist in poisonous form for much longer periods. When crops with residues of certain pesticides are fed to livestock, the poisons accumulate in the body first. Milking cows secrete these poisons in the milk. Young calves, heifers and dry cows store these in body fat and secrete them when they freshen months later. Even the use of bedding from treated grain crops can kill livestock.

Never apply any pesticides or allow sprays to drift to forage, hay or other feed that is to be fed to livestock unless they are specifically recommended. If hay, corn stover, pea vines, bean straw, sugar beet tops, etc., are purchased check on the possibility of their having been sprayed.

When using pesticides, adhere to the waiting period indicated before pasturing, feeding, or harvesting.

Pesticide Storage

Pesticides should be stored in their original containers with labels in place — never in food or beverage containers. They should be kept in a dry place (wall cupboards, etc.) which is kept locked when the products are not being used. Never leave open packages or tins of pesticides around while you are spraying elsewhere.

Safe Disposal of Pesticide Containers

Proper disposal of the empty containers prevents hazard to man and the environment from chemical residues, and eliminates litter. It is in the user's best interest that careful procedures for empty pesticide container disposal be carried out.

Underground disposal is the safest means of handling empty pesticide containers. THIS PROCEDURE MUST INVOLVE TRIPLE-RINSING AND PUNCTURING BEFORE ACTUAL BURIAL.

Triple-rinse

After the container has been emptied, rinse three times and pour the rinsings into the spray tank as part of the make-up water. This ensures that farmers get full use of all the chemical they purchase.

Puncture

Puncture or crush the container after rinsing to prevent it from being reused for purposes that might expose humans or animals to a chemical hazard.

Bury

Bury container in an area well removed from any watercourse and cover it by at least 50 cm of soil. This allows biodegradation of any possible residues which may remain, and avoids hazard and litter.

It is the responsibility of the pesticides user to carry out these procedures. Each farm property should include an appropriate disposal site.

In some circumstances it may become necessary for the empty containers to be taken to local garbage disposal facilities.

Additional Procedures for Safe Disposal

Empty combustible containers (paper bags, cardboard boxes, and plastic containers) may be burned if great care is taken. Stand upwind of the fire, and away from the path of smoke and gases. Be sure that smoke and fumes will not drift to nearby homes, people, livestock or crops and carefully bury all the ashes.

Rules for Chemical Pesticide Safety

Treat all pesticide (insectides, herbicides, fungicides etc.) as poisonous substances and handle them with great caution. They can kill.

1. Read each pesticide label carefully and follow the instructions. The instructions on a pesticide label serve to safeguard the health of the user as well as to ensure the pesticide is employed as efficiently and economically as possible. When in doubt, read the label.
2. Always wear the recommended protective clothing and safety equipment. Pesticides may enter the user's body through the skin, the mouth or by inhalation. The protective equipment worn by the conscientious pesticide applier includes a respirator or gas mask, a wide-brimmed hat, goggles, a shirt with long sleeves over neoprene or rubber gloves, overalls with rubber bands around the cuff, and neoprene or rubber boots. Because fumigants are readily absorbed by neoprene, be sure to follow label instructions.

   Don't follow someone else's bad example. Wear the required safety equipment. It's for your own good.
3. Open, pour, weigh and mix pesticides in a safe manner and according to label instructions. Use the proper tools to open a container. Stand upwind of all opening, pouring, and mixing operations, and in a well-ventilated area. Avoid splashing and spilling.
4. Learn to recognize the typical signs of poisoning and the correct first aid procedures. Keep a first aid kit handy. Some symptoms of acute poisoning are nausea, diarrhea, loss of muscle coordination, stomach cramps, mental confusion, etc.
5. If you feel ill during pesticide application, stop work and seek medical attention at once. Do not carry on because of the work schedule. Always save the pesticide container or the label to assist the medical aid person.
6. Do not permit any person including yourself, to work alone when handling or applying pesticides.
7. Never use your mouth to siphon liquid materials or to blow out a clogged spray nozzle.
8. Keep people and animals away from contaminated equipment and areas until decontamination procedures are complete.
9. Be sure a good supply of lime, sawdust, or other absorbent is available on site to soak up a spilled pesticide.
10. Do not permit anyone unfamiliar with chemical safety practices to carry out cleaning or maintenance procedures. Appropriate protective equipment is necessary for cleaning and maintenance personnel.
11. Always dispose of irreparable faulty protective equipment and contaminated clothing.
12. Do not store pesticides near any food or drink. Store them in a locked, well-marked area and out of the reach of children.
13. Do not keep any food, drink, tobacco, cups or cutlery anywhere in the work areas or work clothes. Refrain from smoking, eating, or drinking while mixing or applying pesticides.
14. Dispose of empty containers by crushing and puncturing and burying in at least 50 cm of soil at a recommended site or on your own property away from watercourses, crops, animals, or human habitation. Recycle 200 L drums if possible. Small pesticide containers should be thoroughly rinsed at least three times with the rinsings being added to the spray mix.
15. After handling pesticides, wash hands carefully before eating, drinking, smoking, or using the toilet.
16. Shower thoroughly, with special attention to hair and fingernails, after each pesticide application is complete. Change clothes daily or more often if any contamination occurs. Wash contaminated clothing separately from normal laundry.
17. Before mixing and applying pesticides, clear all livestock, pets and people from the area to be treated. Apply pesticides only at the correct time and under acceptable weather conditions.
18. Check the application equipment. Look for leaking hoses or connections, plugged or worn nozzles, and examine the seals on the filter openings to make sure they will prevent pesticide spillage.
19. Mix the pesticide at the recommended rate, and apply at the specific dosage on the label. Carry only a sufficient quantity of the pesticide for the job at hand.

Poison Information Centres

The hospitals listed below are equipped and staffed 24 hours a day to provide emergency information on potentially toxic substances and to recommend and give treatment.

Newfoundland

Call 1-709-778-4555

St. John's Poison Control Centre or your local hospital.

Prince Edward Island

Call 1-506-648-6222

Nova Scotia

Call 1-800-565-8161

Izaak Walton Killam Poison Control Centre

New Brunswick

Call 1-506-648-6222

Saint John General Hospital Poison Control Centre or your local hospital

The Metric System

Linear Measures (length)
10 millimetres (mm) = 1 centimetre (cm)
100 centimetre (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

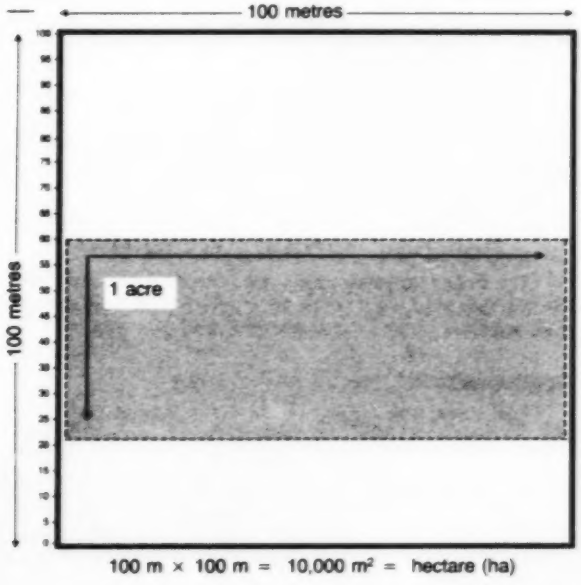
Square Measures (area)
100 m × 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)
1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight Measures
1000 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry – Liquid Equivalents
1 cm^3 = 1 mL
1 m^3 = 1000 L

HECTARE — ACRE PERSPECTIVE



1 litre/ha	= 14.24 fluid oz/acre
1 kg/ha	= 14.5 oz/acre
1 metric tonne/ha	= 0.45 ton/acre
1 kilopascal	= 0.145 lb/sq in.

METRIC EQUIVALENTS

Length

inch	= 2.54 cm	millimetre	= 0.04 in.
foot	= 0.30 cm	centimetre	= 0.39 in.
yard	= 0.91 m	metre	= 3.28 ft.
mile	= 1.61 km	kilometre	= 0.62 mile

Area

square inch	= 6.45 cm^2	cm^2	= 0.16 sq. in.
square foot	= 0.09 m^2	m^2	= 1.20 sq. yd.
square yard	= 0.84 m^2	km^2	= 0.39 sq. mile
square mile	= 2.59 km^2	ha	= 2.47 acres
acre	= 0.40 ha		

Weight

ounce	= 28.35 g	gram	= 0.035 oz.
pound	= 453.6 g	kilogram	= 2.20 lb.
ton	= 0.91 tonne	tonne	= 2205 lb.

Volume (dry)

cubic inch	= 16.38 cm^3	cm^3	= 0.06 cu. in.
cubic foot	= 0.028 m^3	m^3	= 35.32 cu. ft.
cubic yard	= 0.76 m^3	m^3	= 1.31 cu. yd.
bushel	= 36.37 litres		
board foot	= 0.0024 m^3		

Volume (liquid)

fluid ounce (Imp)	= 28.41 ml	litre	= 35.2 fluid oz. (Imp)
pint (Imp)	= 0.57 litre	hectolitre	= 26.42 gal. (US)
gallon (Imp)	= 4.55 litres	hectolitre	= 22.00 gal. (Imp)

Pressure

pound per square inch	× 6.9	kilopascals (kPa)

Proportion — Application Rate Conversions

fluid ounce per acre	× 70	millilitres per hectare (ml/ha)
gallon per acre	× 11.2	litres per hectare (l/ha)
pound per acre	× 1.12	kilograms per hectare (kg/ha)
ton per acre	× 2.24	tonnes per hectare (t/ha)
plants per acre	× 2.47	plants per hectare (plants/ha)

METRIC ABBREVIATIONS

gram	= g	metre	= m
kilogram	= kg	kilometre	= km
hectare	= ha	centimetre	= cm
litre	= l	millimetre	= mm
millilitre	= ml		
hectolitre	= hl		

VALUE OF MANURES

AVERAGE AMOUNTS OF NITROGEN, PHOSPHORUS, AND POTASSIUM OF MANURES FROM DIFFERENT FARM ANIMALS.

Kind of manure	Percent water (%)	kg per ton of manure*		
		N	P_2O_5	K_2O
CHICKEN —				
a. From dropping boards without litter	54	15.5	9.0	4.0
b. With old floor litter**	61	17.0	14.0	7.5
DAIRY CATTLE	79	5.5	2.5	6.0
FATTENING CATTLE	80	7.0	4.5	5.5
HOGS	75	5.0	3.5	5.0
HORSES	60	7.0	2.5	7.0
SHEEP	65	14.0	4.5	12.0

*kg/tonne × 2 = lb/ton.

**Probably contained some feed residues.

SOURCE: Michigan State University Circular Bulletin 231, ANIMAL MANURES.

ESTIMATED REMOVAL OF PLANT NUTRIENTS BY VARIOUS CROPS

CROP	D.M. YIELD (t/ha)	Kilograms per hectare				
		Nitrogen N	Phosphorus P_2O_5	Potassium K_2O	Calcium Ca	Magnesium Mg
Oat Grain	3.1	56	22	17	3	4
Oat straw	4.5	28	11	67	9	10
Barley grain	3.2	56	28	17	2	3
Barley straw	3.4	22	11	50	13	3
Wheat grain	2.7	56	28	17	1	7
Wheat straw	3.4	22	5	39	7	3
Corn silage	12.3	112	56	151	12	21
Alfalfa hay	8.9	213	50	275	132	27
Timothy hay	8.9	151	39	163	20	11
Red clover hay	8.9	168	39	179	121	29

SEEDING RATES FOR MISCELLANEOUS CROPS

Crop	Seeding Rates kg/ha
Field Peas	134
Fababeans	168
Buckwheat	56
Millet	20
Sorghum	13
Fall Turnips [Rutabagas]	1
Sunflowers	7

SEEDS PER UNIT OF FORAGE SPECIES

Crop	Seeds per kg
Alfalfa	440,000
Red Clover	605,000
White Clover	1,760,000
Bird's foot Trefoil	935,000
Sweet Clover	572,000
Alsike	1,540,000
Timothy	2,706,000
Orchard Grass	1,439,000
Bromegrass	300,000
Meadow & Tall Fescue	506,000
Perennial Rye Grass	500,000
Reed Canary Grass	1,173,000
Bluegrass	4,790,000

CONCRETE TOWER SILO CAPACITY FOR HIGH MOISTURE CORN

Silo Diameter	X	Settled Depth	Whole Shelled Corn			Ground Shelled Corn			Ground Ear Corn			
(metres)		(feet)	25%*	30%	35%	25%	30%	35%	30%	35%	40%	
4.9 × 15.2		16 × 50	227	249	275	238	267	301	205	237	276	16 × 50
4.9 × 18.3		16 × 60	274	301	333	288	323	365	249	287	335	16 × 60
4.9 × 19.8		16 × 65	298	327	362	313	351	397	271	313	365	16 × 70
5.5 × 15.2		18 × 50	289	318	351	303	340	384	263	303	353	18 × 50
5.5 × 18.3		18 × 60	350	384	425	367	412	466	318	368	429	18 × 60
5.5 × 21.3		18 × 70	410	451	499	431	484	547	374	434	506	18 × 70
6.1 × 18.3		20 × 60	434	477	528	456	512	579	396	459	535	20 × 60
6.1 × 21.3		20 × 70	510	561	620	536	602	680	466	541	631	20 × 70
6.1 × 24.4		20 × 80	585	644	713	616	692	782	536	622	727	20 × 80
7.3 × 18.3		24 × 60	632	694	768	663	745	841	578	670	781	24 × 60
7.3 × 21.3		24 × 70	742	816	902	780	876	989	681	770	992	24 × 70
7.3 × 24.4		24 × 80	852	938	037	896	1007	1132	784	910	1063	24 × 80
7.3 × 27.4		24 × 90	963	1059	1172	1012	1138	1285	887	1030	1204	24 × 90
9.1 × 24.4		30 × 80	1346	1480	1637	1413	1587	1791	1242	1442	1681	30 × 80
9.1 × 27.4		30 × 90	1521	1673	1851	1597	1794	2025	1405	1633	1905	30 × 90
9.1 × 30.5		30 × 100	1697	1867	2064	1781	2001	2258	1569	1824	2128	20 × 100
9.1 × 33.5		30 × 110	1872	2060	2278	1965	2208	2592	1734	2016	2352	30 × 110

1 tonne = 1000 kg = 2200 lb. = 1.1 ton

*Percent moisture.

SOURCE: OMAF Factsheet 100/732 Tower Silo Capacities.

CONCRETE TOWER SILAGE CAPACITY FOR HIGH HAYLAGE AND SILAGE

Diameter Silo	X	Settled Depth	Alfalfa Haylage				Corn Silage		
(meters)		(feet)	60%*	50%	40%	30%	35%	30%	
4.9 × 15.2		16 × 50	109	137	181	261	191	224	16 × 50
4.9 × 18.3		16 × 60	135	169	224	323	235	275	16 × 60
4.9 × 19.8		16 × 65	147	185	245	354	258	300	16 × 65
5.5 × 15.2		18 × 50	142	178	236	339	247	288	18 × 50
5.5 × 18.3		18 × 60	176	221	293	421	304	353	18 × 60
5.5 × 21.3		18 × 70	211	264	351	504	361	419	18 × 70
6.1 × 18.3		20 × 60	224	281	372	533	381	442	20 × 60
6.1 × 21.3		20 × 70	268	337	446	639	453	525	20 × 70
6.1 × 24.4		20 × 80	314	394	522	746	526	607	20 × 80
7.3 × 18.3		24 × 60	338	423	559	796	560	647	24 × 60
7.3 × 21.3		24 × 70	407	511	674	956	667	767	24 × 70
7.3 × 24.4		24 × 80	479	600	790	1118	737	888	24 × 80
7.3 × 27.4		24 × 90	551	690	908	1281	880	1009	24 × 90
9.1 × 24.4		30 × 80	796	993	1297	1813	1343	1480	30 × 80
9.1 × 27.4		30 × 90	920	1146	1494	2079	1547	1706	30 × 90
9.1 × 30.5		30 × 100	1046	1301	1692	2346	1754	1934	20 × 100
9.1 × 33.5		30 × 110	1173	1457	1891	2614	1962	2165	30 × 110

1 tonne = 1000 kg = 2200 lb. = 1.1 ton

*Percent dry matter.

Capacities for grass silage may be estimated by increasing the alfalfa haylage by 10, 15 and 20% for the dry matter contents of 50, 40 and 30% respectively.

SOURCE: OMAF Factsheet 100/732 Tower Silo Capacities.

HORIZONTAL SILO CAPACITIES

Width (m)	Tonnes of Dry Matter per Meter Length		
	Height (m)		
	2.5	3.0	3.5
5	2.5	2.8	3.3
6	2.9	3.4	4.0
7	3.5	4.1	4.7
8	4.0	4.7	5.5
9	4.6	5.5	6.2
10	5.2	6.0	7.0
12	6.5	7.5	8.6
14	7.8	9.0	10.3
16	9.2	10.6	12.0
18	10.7	12.3	13.9
20	12.2	14.0	15.8

Use of Table

Silage to be stored 500 tonnes at 35% dry matter

$= 500 \times \frac{35}{100} =$ 175 tonnes of dry matter

Length of 9 × 3 meter silo $= \frac{175}{7.5}$ (see table) = 23.3 meters

or

Length of a 9 × 2.5 meter silo $= \frac{175}{4.6}$ (see table) = 38.0 meters

Source: Forage Handling Systems for Grass and Legumes.

1 meter = 3.28 feet.

Machine Calibrations

The calibrations below are presented in metric units. Appropriate English units may be substituted directly (see page 47).

A. Broadcast Seeders

1. Fill hopper with seed.
2. Set rheostat to give desired swath width. Adjust machine control setting to approximately the desired application rate. Make certain machine is functioning properly.
3. Refill hopper and mark level of seed on a measuring stick.
4. Run seeder for 5 minutes.
5. Refill hopper to its original level, weighing amount of seed required to do this.
6. Divide the amount of seed broadcast in 5 minutes by five, to obtain output of seeder at the particular setting in kg per minute.
7. The application rate in KILOGRAMS PER HECTARE is then:

$$\frac{\text{Seeder output (in kg/min)} \times 600^*}{\text{Swath width (in metres)} \times \text{km/ha}}$$

*the number 600 is a constant obtained by multiplying the number of square metres in a hectare by the number of minutes in an hour and dividing by the number of metres in a kilometre, i.e., 10,000 × 60 ÷ 1,000 = 6,000. This constant is 495 if English units are used.

B. Full Width Machines (Grain Drills and Fertilizer Spreaders)

1. Choose a machine control setting that seems close to the application rate desired. Make certain the machine is functioning properly.
2. Jack machine up so that the drive wheel or wheels can be turned.
3. Partially fill hopper with seed.
4. After setting the machine control, turn the drive wheel or wheels 10 times.
5. Collect and weigh the grain delivered during the 10 wheel turns.
6. The application rate in KILOGRAMS PER HECTARE is then:

$$\frac{\text{Kilograms collected} \times 31{,}831^*}{\text{Wheel diameter (cm)} \times \text{Machine width (m) (metres)}}$$

*The number 31,831 is a constant obtained by multiplying the number of square metres in a hectare by the number of centimetres in a metre and dividing by 10 (the number of wheel turns) multiplied by (3.1416), i.e., (10,000 × 100) ÷ (10 × 3.1416) = 31,831. This constant is 16640 if English units are used.

C. Sprayers

1. Set out two stakes 100 metres apart.
2. Pick a level spot and fill sprayer tank with water. Operate sprayer to be sure the supply line up to the shut-off valve is full before finally filling the tank. RECORD THE WATER ON A MEASURING STICK.
3. Spray between stakes IN BOTH DIRECTIONS at a DEFINITE SPEED AND PUMP PRESSURE. Turn boom on as first stake is passed in each direction. The by-pass pressure relief value must be set to give the desired pressure when the shut-off valve is open. MARK THE THROTTLE SETTING.
4. Return sprayer to same location as before the calibration run. Carefully measure amount of water required to refill tank to the same mark on the measuring stick.
5. Calculate the application rate in LITRES PER HECTARE.

$$\text{litres/ha} = \frac{\text{Litres of Water Added} \times 50}{\text{Number of Nozzles} \times \text{Nozzle Spacing (cm)}} \times 100$$

Sample Calculation: After spraying 200 metres once (or 100 metres twice), it took 20 litres to refill the sprayer. There were 13 nozzles on the boom at 50 cm (20 in) spacings.

$$\text{l/ha} = \frac{20 \text{ Litres} \times 50}{13 \text{ nozzles} \times 50 \text{ cm}} \times 100$$

$$\text{l/ha} = \frac{1000}{650} \times 100$$

$$\text{l/ha} = 154$$

Equations: litres/acre = l/ha × 0.4 Gallons/acre = l/ha × 0.09

Another calibration method involves using the "Sprayer Calibration Bottle", which may yield a better overall accuracy on water volume per hectare if all the nozzles are checked. Follow the directions printed on the manufactured calibration bottle. Sprayer calibration bottles can be obtained from your Provincial Department of Agriculture.

There are two types of calibration bottles. The first type attaches onto the sprayer boom directly underneath the nozzle. Stake out the area stated by the manufacturer on the bottle and spray between the stakes in the gear you intend to spray. The bottle is calibrated in litres per hectare or gallons per acre of water volume.

The second type does not attach to the boom. Stake out the area stated by the manufacturer and time how long it takes to travel between the two stakes. Turn on the sprayer and hold the bottle underneath the nozzle for the same amount of time. Again the bottle will show the water volume in litres per hectare or gallons per acre of water volume.

It is important to check several nozzles when using both options to ensure that the spray pattern is even. Take the output form several nozzles for 10-15 seconds in a bottle of known volume or a calibration bottle. If the nozzle is not putting out the same water volume, clean it and recheck it. New nozzles may have an accuracy of ± 5%. If your nozzles differ from each other by over 10%, buy new ones. If you have any doubts about the nozzles replace them.

It is IMPORTANT to keep a written record of tractor identification, R.P.M., gear, water volume output and spray information (weather, temp., which pesticide in which field, etc.).

COUNTY AND DISTRICT OFFICES OF THE DEPARTMENTS OF AGRICULTURE OF THE ATLANTIC PROVINCES

New Brunswick

REGION	OFFICES	PHONE	SPECIALIST
NORTHWEST	Box 5001 Grand Falls E0J 1M0	473-5515	Grand Falls 473-5515
	Box 428 Saint Quentin E0K 1J0	235-2683	
	121 Church St. Edmundston E3V 1J9	735-2060	
NORTHEAST	1425 King Ave. Bathurst E2A 1S7	547-2088	Bathurst
	Box 1148, Dalhousie E0K 1B0	684-4253	
WESTERN	Wicklow, RR# 2, Florenceville E0J 1K0	392-6007	Wicklow 392-6007
	Perth-Andover Box 68 E0J 1V0	273-2269	
MIRAMICHI	372 Water Street, Chatham E1N 1B6	778-6030	
SOUTHWEST	Box 5001, Sussex E0E 1P0	432-2000	
	Box 6000, Fredericton E3B 5H1	453-2272	
SOUTHEAST	Moncton, Box 5001 E1C 8R3	856-2277	
REXTON	Richibucto, Box 5001 E0A 2L0	523-7600	
	Middle Sackville E0E 1E0	536-0972	

PROVINCIAL SPECIALISTS

P.O. Box 6000
Fredericton, N.B.
E3B 5H1

Plant Industry Branch

Forage Crops	453-2172
Cereal Crops	453-2172
Insects	453-2108
Diseases	453-2108
Weeds	453-2108
Soil - Fertility	453-2109
- Management	453-2109
- Laboratory	453-2109

Market Development Branch

Market Development Officer	453-2214

Grain Commission

General Manager	453-2185

Agricultural Engineering Branch

Engineering	453-2272

Livestock and Poultry Branch

Livestock Nutritionist	453-2457

Prince Edward Island

District	Agricultural Representatives	Telephone	Specialist	Telephone
West Prince	West Prince Regional Services Centre P.O. Box 8, O'Leary C0B 1V0	859-2400	Crops Specialist	368-5640
			Cereal & Protein Specialist	368-5633
			Forage Specialist	368-5634
Summerside	East Prince Regional Services Centre 109 Water Street, P.O. Box 2063 Summerside C1N 5L2	436-9248	Agricultural Research and Extension Bldg. P.O. Box 1600 Charlottetown	
Charlottetown	Agricultural Research and Extension Building, P.O. Box 1600, Charlottetown C1A 7N3	368-5655	PEI Grain Elevators Corporation General Manager	836-3605
Montague	Southern Kings Regional Services Centre, P.O. Box 1500, Montague C0A 1R0	838-2992		
Souris	Eastern Kings Regional Services Centre P.O. Box 550, Souris C0A 2B0	687-7040		

Newfoundland

District	Agricultural Representatives	Telephone	Fax	Specialist
Western Region	P.O. Box 69 McKays, NFLD A0N 1G0	645-2711	645-2554	Crop Specialist P.O. Box 340 Pasadena, NFLD A0L 1K0 686-5262 Fax 686-2491
	P.O. Box 340 Pasadena, NFLD A0L 1K0	686-2702	686-2491	
	P.O. Box 2006 Sir Richard Squires Bldg. Corner Brook, NFLD A2H 6J8	637-2430	637-2549	
Eastern Region	Provincial Agriculture Building P.O. Box 8700 Brookfield Rd St. John's, NFLD A1B 4J6	729-2635	729-6046	Crop Specialist Prov. Agric. Bldg. P.O. Box 8700 St. John's, NFLD., A1B 4J6 729-6821, 729-6867 Fax 729-6046
	P.O. Box 569 Harbour Grace, NFLD A0A 2M0	596-5040	596-2115	
	P.O. Box 569 Clarenville, NFLD A0E 1J0	466-2558	466-3802	
Central Region	P.O. Box 352 Gander, NFLD A1V 1W7	256-1042	256-1013	Crop Specialist P.O. Box 640 Bishop Falls, NFLD A0H 1C0 258-5334 Fax 258-5873
	P.O. Box 640 Bishops Falls, NFLD A0H 1C0	258-5334	258-5873	

Nova Scotia

County	Agricultural Representatives	Telephone	Specialists	Telephone
Antigonish	11 James St., Antigonish, B2G 1R6	863-4705 863-4706		
Cape Breton	Provincial Building, Sydney, B1P 5L1	563-2000	P.O. Box 550, Truro	
Colchester	P.O. Box 550, Truro, B2N 5E3	893-6592	B2N 5E3	
Cumberland	Experimental Farm, Nappan, B0L 1C0	667-8722	Provincial Soil and Crop Specialists	893-6558
Inverness	P.O. Box 70, Mabou, B0E 1X0	945-2999 945-2340	Forages, Corn & Grain Spec. P.O. Box 550, Truro	893-6566
Halifax	Middle Musquodoboit, P.O. Box 97, B0N 1X0	384-2262	B2N 5E3	
Pictou	P.O. Box 160, Pictou, B0K 1H0	485-4317	Regional Soil and	679-6027
Annapolis	Lawrencetown B0S 1M0	584-2231	Crop Specialist	679-6029
Digby	P.O. Box 309, Weymouth, B0W 3T0	837-5161 837-5162	Research Station Kentville, B4N 1J5	
Hants	P.O. Box 248, Windsor, B0N 2T0	798-8377 789-8378	Nova Scotia Grains Commission	679-6025
Kings	Research Station, Kentville, B4N 1J5	678-7365	Secretary/Manager	
Lunenburg	99 High Street, Bridgewater, B4V 1V8	543-0505	Research Station	
Yarmouth	10 Starr's Road, Yarmouth, B5A 2T1	742-4334	Kentville, B4N 1J5	